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ENGINEERING NEWS.

THE HASTENING OF WORK ON THE SAULT CANAL is urged by the Cleveland Board of Trade in a resolution forwarded to Congress. The resolution states that, owing to insufficient appropriations or none at all, the work on the new lock at the Sault Ste. Marie ship canal and the improvement of the St. Mary River and the Hay Lake Channel is alarmingly behind the enormous increase of the tonnage of Lake Superior. This tonnage has increased from 2,207,105 tons in 1883 to an aggregate of 7,400,000 for the season of 1889. The last appropriation was made for this work in August, 1888, but a whole year's time was practically lost by the non-passage of the River and Harbor Bill. At the present rate of construction, five to seven years more will be required for completion.

THE CASE OF NEWARK VS. PASSAIC, regarding pollution of the Passaic River by the latter city, was argued last week. The suit was brought by the Newark Aqueduct Board, insisting that Newark had a right in the waters of this river and that it was the duty of the Board to preserve its purity; further, that if the present drainage plan of Passaic is carried into effect, it will cause the people of Newark to abandon the water, deprive the Water Board of most of its revenue, and render expensive work valueless. Passaic, on the other hand, argued that that city had lawful power and authority to construct its sewers; that the Newark Aqueduct Board had no rights with which Passaic proposed to interfere; that Newark had no greater rights to the water than the general public, and finally, that it was not certain that Newark would suffer an injury.

THE PENNSYLVANIA COUNTY ROAD COMMISSION has been appointed, in accordance with the resolution of March last, of the Pennsylvania Legislature. Senators HARLAN, MYLIN, and SLOAN and Representatives FOIGHT, MCCULLOUGH, FOULKNER, GRIFFITH and SHILLITO represent the Legislature, and the five citizens selected to act with them are DAVID MCCARGO, JACOB BOLLARD, CYRUS GORDON, H. S. GOODWIN, and SAMUEL R. DOWNING.

THE BLOCK SYSTEM is to be introduced on the Pittsburg, Fort Wayne & Chicago road, between Allegheny City and Highland, Pa., 36 miles. Near Allegheny, where there is considerable local traffic, the blocks will be about 1 mile apart, but they will be longer as the traffic decreases, being 5 miles long at the end of the section.

THE RICHTER SYSTEM OF ELECTRIC RAILWAY, in which the current is conveyed through wires laid in an underground conduit between the rails, is on exhibition, in miniature, at the office of the Richter Electric Construction Co., 20 Cortlandt St., New York. The cost is said to be greater than that of systems using overhead wires, but it is applicable to city streets, where overhead wires are out of the question. A really practicable and economical system of electric railway using a conduit for its wire circuit will probably find a wide field for its introduction, and we wish the Richter system success. We shall probably publish a description of this system in a later issue.

THE PNEUMATIC RAILWAY CO., of 607 Chestnut St., Philadelphia, proposes to run street cars, or even "to supplant the locomotive itself," by a system of pneumatic propulsion. In the 45 ft. of experimental line now built, a 6-in. tube is provided with a continuous slot on top, covered by a series of tightly fitting plates, capable of being slid off by the "coulter," connected with a plate running to the car above. Inside the tube are two leather pistons, about 2 ft. apart, connected with the car-plate, and snugly fitting the tube. Compressed air or a vacuum may be used for propelling the pistons and the car attached, a pressure of 280 lbs. per sq. inch being used in this case. Great economies are claimed for this system as applied to main lines of railway traffic; but it is evident that a number of practical difficulties will have to be overcome before these economies can be realized.

THE BROOKLYN BRIDGE annual report shows the following increase of railway traffic in the past three years:

Year ending Nov. 30.	*No. Ry. Pass'rs.*	*Increase.*
1887	27,940,313	
1888	30,831,283	2,890,970
1889	33,954,773	4,623,490

The highest number of passengers on any one day (April 30, 1889) was 159,259, or over 73 passengers per car average, for all day and both directions. The highest daily average for any one month (November, 1889) was 104,706, or 3,141,165 for the month. Among the items of expense is one of $8,000 in settlement of the claim of CHAS. E. EMERY for services as consulting engineer.

ANOTHER LINEMAN, PETER CLAUSEN, was killed, on Dec. 9, by a current from an electric light wire at the corner of 156 St. and Third Ave., New York. The circumstances were much the same as those that caused the death of Lineman FEEKS a few weeks ago. The matter is being "investigated."

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a collision Dec. 5, on the Chicago, St. Paul & Kansas City road at Durango, Ia. A freight train was standing on a sidetrack to let another freight train pass; this second train was in four sections, and after three sections had passed, one of the brakemen of the standing train opened the switch; the fourth section ran onto the sidetrack and an engine and seven cars were wrecked. Two men were killed.——Two misplaced switch accidents are reported; one on the Pennsylvania Railroad near Greensburg, Pa., Dec. 4, in which an express train was turned onto a sidetrack and collided with a freight train; about eight persons were seriously injured. The other was on the Lake Shore & Michigan Southern Railway, at Dune Park, 35 miles from Chicago, on Dec. 6; the New York limited express, westbound, was turned onto a sidetrack and collided with a train of sand cars; the engine and three cars were wrecked, and three persons were injured. The switch is said to have been misplaced or broken by a passing eastbound train. This list of three accidents in one week again shows the necessity for the use of efficient switch and switch protecting apparatus.——Two sleeping cars of an Illinois Central train were burned Dec. 5, while the train was running near Arcola, Ill. A lamp exploded and set one car on fire, and owing to some failure in the bell cord, the engineer could not be signaled at once, and the flames were carried back to the next car. Some of the passengers lost their hand baggage.

A SERIOUS DERAILMENT ACCIDENT occurred to a vestibuled express train on the Louisville, New Albany & Chicago Railway, near Frankfort, Ind., Dec. 8. The press account is as follows: While the train was running at the rate of about 45 miles an hour the rear trucks of the tender left the track, "causing a disconnection of the air-brake and leaving the engineer powerless to check the speed of the train," from which newspaper statement we infer that the train was not provided with the automatic brake. It went onto a trestle about 900 ft. in length. Here the baggage car and one coach left the track, and, after ploughing through the ties and timbers for a few feet, went over into the creek, 15 ft. below, and were completely demolished. The chair and dining cars, though they left the track also, remained hanging to the trestle and were not badly damaged. Only three persons were injured, and these not seriously. The trestle is said to have been in bad condition. This accident again shows the necessity of the wider use of rerailing devices.

A LANDSLIDE near Delta, Cal., on the Southern Pacific, caused the wreck of a freight train Dec. 1. One man was killed and two were injured.

AN EARTHQUAKE SHOCK was felt at Alton, Alton Bay, and Gilford, N. H., on Dec. 3.

THE BOSTON BOARD OF FIRE UNDERWRITERS, representing substantially all the fire insurance companies doing business in Boston, has petitioned the Mayor and City Council to increase the force of the fire department, and to take steps to bring about a revision of the building laws. With reference to overhead electric wires the following is recommended:

> That such an appropriation be made as may be necessary to enable either the fire alarm department or such other authorities as may be designated to immediately remove from the tops of the buildings and from the streets of Boston the vast collection of dead electric wires, which are, in consequence of disuse and neglect, a constant menace to the lives and property of our citizens.
>
> The Board of Fire Underwriters is of the opinion that action should be taken to systematically regulate all of the electric wires that are in use in this city, and that prompt measures should be adopted to remove the various wires which now run suspended upon poles, along the fronts of high buildings in many of our public streets, and which, by their number and location, make it all but impossible for the fire department to do effective work in extinguishing fires that may occur in the buildings where these obstructions exist.

AN EXHIBITION OF THE BOYDEN BRAKE COMPANY'S quick-acting brake was recently made on the Baltimore & Ohio. A train consisting of an engine and 5 cars, the latter weighing in all about 180 tons, was run from Baltimore to Annapolis Junction and return, about 19 miles. The rear car and the tender had the Westinghouse automatic brake, old style. The other cars and the engine were equipped with the Boyden apparatus. Only one emergency stop was made, in which, according to reports, the train was stopped in a distance of 780 ft. and a time of 21 seconds while running at 55 miles per hour on a grade of 0.85 per cent.

It is claimed that this brake is so quick acting that it may be applied to long trains of freight cars. It would be of much interest to have careful tests of the brake made on such long trains as those used in the Burlington tests.

MEMPHIS BRIDGE PROGRESS.—According to the last accounts Pier 2 is down and Pier 4 is nearly completed. Pier 1, which will be on the Memphis side, has not yet been commenced. Pier 2 stands on a caisson 47 by 92 ft. and 40 ft. deep, and now has 68 ft. of masonry on top of it, extending 2 ft. above the river surface. Pier 3 was launched several weeks ago; but the rapid rise in the river and the powerful current acting on the large submerged crib surface has caused trouble; several of the anchor lines were broken and the crib was 40 or 50 ft. out of place. Wire rope, 1¼ in. diameter, and crib anchors were used; the fourteen anchor lines have an aggregate resistance of 1,000 tons against the current. Chief Engineer NOBLE is busy at work

attempting to relocate the crib and sink it. The span between piers 1 and 2 will be 791 ft.; then come two spans of 621 ft. each and a fourth span of 350 ft.; beyond that will be nearly one mile of 150 ft. spans. The clear headway under the bridge will be 75 ft. The estimated cost is $3,000,000. Work was commenced in October, 1888.

The Consumption of Railway Ties in France

Mr. H. MATHIEU has lately written an interesting paper upon the consumption of railway ties in France between 1878 and 1886, and from the translation in the "Abstracts" of the Inst. C.E., the following matter is condensed:

The total length of single track of the six main railway systems in France amounts to 93 per cent. of the total length of single track in that country, and the general deductions made from the exhibit are taken as applicable to the entire railway system. The final results are tabulated as follows:

Year	No. of ties consumed on all the railways of France	Total length		No. of ties consumed per mile single track
		of railway miles	of single track miles	
1887	2,405,538	21,114	29,256	82.2
1888	2,521,270	21,543	29,914	84.3

The consumption of ties for maintenance during previous years, including 1887-1888, was as follows:

	Ties per mile per year.
1878 to 1882	148.1
1883	120.7
1884	142.7
1885	111.9
1886	87.8
1887	82.2
1888	84.3

This remarkable and steady reduction in the number of ties used annually for maintenance is attributed to the greater degree of care exercised by the companies; to new methods adopted for replacing ties; to the creosoting of all kinds of wood used for ties; to better fastenings; to the selection of good ballast; and to the augmented weight and strength of rails.

The total number of ties consumed for construction and maintenance on new French lines was as follows:—

	Maintenance.	*Construction.*	*Total.*
1887	2,405,538	1,452,094	3,857,632
1888	2,521,270	1,280,000	3,801,300

The ties are generally oak, with beech and fir next in quantity. About 93½ per cent. come from the forests of France. Metal ties are still on trial on the State railways, with 45,000 of all kinds in use.

The National Electric Protector Against "Burn-Outs."

In connection with the multiplication of electric wires and the frequent burning out of telephones and fire-alarm boxes, the National Electric Protector Co., of 18 Broadway, New York, calls renewed attention to its device for preventing accidents of this kind. It comes in in timely accord with other articles on fire protection published in this and previous issues.

The instrument itself is a small one, (6 X 2½ ins.) and contains a single electro-magnet wound with coarse wire to a very low resistance, or about one-tenth of an ohm. This magnet is placed in the circuit of the telephone or any electric system used, and remains quiescent until the circuit becomes abnormally charged by atmospheric, electric light, or other strong currents. When this happens the magnet attracts the armature and automatically grounds or shuts off the strong current as long as it lasts. When the excess of current ceases, the armature is released and the circuit is restored to its normal condition.

It has been in use for about five years and has stood the most severe "duty tests." The protector has been adopted by the fire alarm telegraph system in a number of large cities in the United States.

Economy in Bridging Rivers.*

When a bridge has to be built, a number of problems arise, all of which have something to say regarding the economy of the structure, the site for the bridge, the style of the bridge (Howe, Pratt, Whipple, suspension, arch, cantilever, etc.), the material to be used in the substructure (wood, iron, steel, concrete, stone, etc.); the moving load to be provided for; the allowable unit stresses for the different materials under the various conditions; the number and length of spans into which the bridge is to be subdivided,—are all problems which have to do with the economy of the structure, and therefore demand the judgment of those having the necessary experience.

The present article deals with the last of the above problems only, viz., the economical span.

The cost of a bridge is obtained by adding the cost of the substructure or piers to the cost of superstructure or spans. Now the cost per lineal foot of span increases with the length of span, so that the shorter the span the less would be the cost of bridge, if it were not for the fact that the number, and therefore the total cost, of piers is increased by a decrease of span. It is, therefore, inferred that the length of span must not be reduced beyond a certain point. This point or span is called the economical span, since a longer or shorter span will increase the total cost of bridge. It is obvious that a longer span than this will increase the total cost of bridge because the increased total cost of spans will more than compensate for the reduced total cost of piers, whilst a shorter span will also increase the total cost of bridge because the increased total cost of piers will more than compensate for the reduced total cost of spans.

The theory is general amongst engineers that the economical span is that span which costs as much as one pier. This theory is based upon the assumption that the cost of span varies as the square of its length. It will be seen, however, from the following that this assumption is incorrect and gives incorrect results. In the following table will be seen a case (100-ft. span, Class M) where the economical span costs nearly five times the cost of one pier, and the writer has met with one case where the economical span cost as much as eight times the cost of one pier.

So far as the writer is aware, the economical span, or what was thought to be the economical span has been, up to the present time, obtained by rule of thumb, or upon the assumption before mentioned; and it does not require much experience to prove that judgment upon this point has been anything but accurate. The results obtained by the following investigation can be as accurate, however, as we choose to make them.

The method used to obtain the economical span has been as follows: first the curve representing the cost of different spans was plotted; by the aid of this curve an equation (1) representing this cost was found by trial; from the equation of the total cost of structure (2), the cost of pier for a minimum total cost of structure was derived by differentiation.

In the following let

a = constant.
b = constant.
c = cost of one span in dollars.
p = " " pier "
l = total length of structure in feet.
n = number of spans.
s = length of one span in feet = $\frac{l}{n}$.
y = total cost of structure in dollars.

From the curve above mentioned, plotted from estimated cost of spans of 100 ft. to 200 ft., the following equation of a parabola was deduced:

$$c = a + \frac{(s-20)^2}{b} \quad \ldots\ldots (1)$$

Now since there are n spans, there are $n+1$ piers, and therefore the total cost of bridge

$$y = n.\ c + (n+1)\,p \quad \ldots\ldots (2)$$

and from above

$$c = a + \frac{(s-20)^2}{b} = a + \frac{\left(\frac{l}{n}-20\right)^2}{b}$$

$$\therefore\ y = n\,a + \frac{l^2}{b\,n} - \frac{40\,l}{b} + \frac{400\,n}{b} + n.\ p + p.$$

$$\text{and } \frac{dy}{dn} = a - \frac{l^2}{b\,n^2} + \frac{400}{b} + p = 0, \text{ for a minimum.}$$

$$\therefore\ p = \frac{s^2 - a.\ b - 400}{b} \quad \ldots\ldots (3)$$

that is, the cost of bridge is least when the cost of pier equals

$$\frac{s^2 - a.\ b - 400}{b}$$

In a valuable paper read June 10, 1884, by Mr. GEORGE H. PEGRAM, before the American Society of Civil Engineers, is given a series of actual weights of single track through bridges. These bridges are designed to a good specification, and are mostly to the following three classes of loading:

Class M.—Two coupled mogul engines, followed by a train weighing 1,820 lbs. per ft. of track.

Class C.—Two consolidation engines, followed by a train weighing 2,240 lbs. per ft. of track.

Class T.—Two "Typical" consolidation engines, followed by a train weighing 3,000 lbs. per ft. of track.

The distribution of weight in the several classes being shown in the following diagrams:

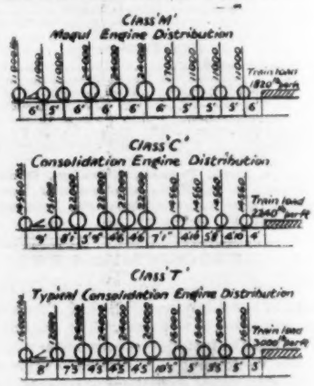


Diagram Showing Distribution of Engine Load.

From the shipping weights given by Mr. PEGRAM, the cost of spans varying from 80 ft. to 201.5 ft. were calculated, on the basis of 4 cents per lb. for the finished iron work delivered at the site, $1.50 as the cost per lineal foot of floor (ties, guards, and bolts), and $5 per lineal foot as the cost of erection. These figures are of necessity only approximate, and greater accuracy is not required, for it will be seen from the table below that a considerable variation from them would be allowed before the economical span would be changed.

From the cost of spans obtained in this manner, the values of the constants a and b in equation (1) were found to be as follows:

	Class M.	*Class C.*	*Class T.*
a	2.220	2,130	2,120
b	3.38	3.1	2.89

With these constants the following table was derived from equations (1) and (3), except the cost of the 60 ft. and 200-ft. spans, the former of which was obtained direct from Mr. PEGRAM's tables and the latter from his formula:

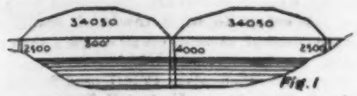
TABLE GIVING COST OF PIER AND ECONOMICAL SPAN.

Length of span.	Class M.		Class C.		Class T.	
	Pier.	Span.	Pier.	Span.	Pier.	Span.
60						1,970
100	,860	4,110	1,720	4,190	1,470	4,330
110	1,480	4,610	1,970	4,740	2,200	4,920
120	2,160	5,170	2,640	5,350	3,010	5,570
130	2,900	5,800	3,440	6,030	3,880	6,300
140	3,700	6,470	4,310	6,770	4,800	7,100
150	4,550	7,220	5,270	7,570	5,800	7,970
160	5,480	8,010	6,240	8,450	6,880	8,900
170	6,440	8,870	7,290	9,380	8,030	9,900
180	7,470	9,770	8,400	10,370	9,230	10,970
190	8,560	10,760	9,630	11,430	10,500	12,120
200	9,720	11,790	10,900	12,560	11,860	13,330
300						34,050

*Written for ENGINEERING NEWS by ALFRED D. OTTEWELL, San Francisco, Cal.

In illustration of the use of this table the following examples from Class T may be cited.

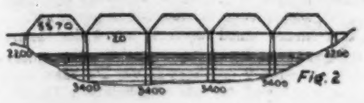
Example I.—Given a profile as in the following sketch, and suppose the bridge to consist of 2—300 ft. spans.



The estimated cost of the parts of this bridge are:

2—300 ft. spans	@ $34,050 =	$68,100
1 pier	" 4,000 =	4,000
2 "	" 2,500 =	5,000
Total cost of bridge,		$77,100

The question arises, Would a reduction of span produce an increase in the cost of substructure more

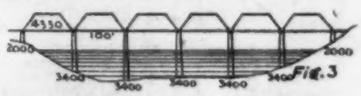


than sufficient to compensate for the decreased cost of superstructure? This question is answered in the negative by the above table, since in the example given the average cost of pier is $\frac{2 \times 2500 + 4000}{3}$ = $3,000 and the span corresponding to this is 120 ft.

Using 120 ft. spans, the cost becomes

5—120 ft. spans	@ $5,570 =	$27,850
4 piers	" 3,000 =	12,000
2 "	" 2,200 =	4,400
Total cost of bridge,		$45,250

for a bridge equally as strong as the one costing $77,100.



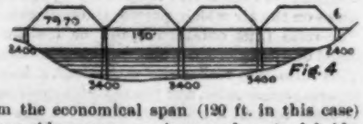
If 100-ft spans were used, the cost would be

6—100 ft. spans	@ $4,330 =	$25,980
5 piers	" 3,400 =	17,000
2 "	" 2,000 =	4,000
Total cost of bridge,		$46,980

whilst if 150-ft. spans were used, the cost would be

4—150 ft. spans	@ $7,970 =	$31,880
3 piers	" 3,400 =	10,200
2 "	" 2,400 =	4,800
Total cost of bridge,		$46,880

the two latter examples showing that a deviation



from the economical span (120 ft. in this case) on either side means an increased cost of bridge.

In using this example, the writer does not claim that a practical engineer would use 300-ft. spans in this case unless he had special reasons for doing so, the example being cited to show how much ($31,250 in this case) he is paying for those special reasons. Knowing this, he can better decide whether his reasons are worth that amount.

Example II.—In further illustration of the use of the above table the problem may appear in this way. Given a profile as in the former example, and suppose the bridge to be built of six 100-ft. spans, as in Fig. 3, at a cost of $46,980. The question then becomes, Would an increase of span allow a reduction in the cost of substructure sufficient to compensate for the increased cost of superstructure? This question is answered in the affirmative by the above table, since five 120 ft. spans, as in Fig. 2, would cost $45,850, that is $1,130 less.

It should be noted that the cost of piers given in the above table can be used for spans of 100 ft. to 200 ft. and above, but they cannot be used with certainty when comparing spans 100 ft. or a little above 100 ft. with spans below 100 ft., since the costs of the latter vary under a law differing from that embodied in Equation (1), and are less than would be obtained from Equation (1). For example, suppose a bridge of five 60-ft. spans at $1,970 and six piers of average cost of $1,470. Reference to the table will show that $1,470 corresponds to a span of 100 ft., but a bridge composed of three 100-ft. spans at $4,330 and four piers at $1,470 will costs $18,870, whilst the bridge composed of 60-ft. spans would cost $18,670. This is due to the fact stated above, that the cost of spans less than 100 ft. is not included in Equation (1). Nor are spans above 200 ft. included in this equation, but the cost of piers given in the table can be used in comparing such spans, since the actual cost of such spans is greater than that given by Equation (1).

The Cost of Pile Driving.

From Prof. IRA O. BAKER'S treatise on Masonry Construction, recently published, we extract, by permission of the author, the following data as to the cost of driving piles under different conditions. It will be noted that the figures are taken from actual practice of recent date; and may therefore be taken as reliable guides in making up estimates.

Cost of Piles.—At Chicago and other points on the Mississippi above St. Louis, pine piles cost from 10 to 15 cts. per lin. ft. according to length and location. Soft-wood piles, including rock elm, can be had in almost any locality for 8 to 10 cts. per ft. Oak piles 20 to 30 ft. long cost from 10 to 12 cts. per ft.; 30 to 40 ft. long, from 12 to 14 cts. per ft.; 40 to 60 ft. long, from 20 to 30 cts. per ft.

Cost of Pile Driving.—There are many items that affect the cost of work which cannot be included in a brief summary, but which must not be forgotten in using such data in making estimates.

Below is the cost for a number of classes of work:

Railroad Construction.—The following table is a summary of the cost, to the contractor, of labor in driving piles (exclusive of hauling) in the construction of the Chicago branch of the Atchison, Topeka & Santa Fé R. R. The piles were driven, ahead of the track, with a horse-power drop-hammer weighing 2,200 lbs. The average depth driven was 13 ft. The table includes the cost of driving piles for abutments for Howe truss bridges, and for the false work for the erection of the same. These two items add considerably to the average cost. The contractor received the same price for all classes of work. The work was as varied as such jobs usually are, piles being driven in all kinds of soil. Owing to the large amount of railroad work in progress in 1887, the cost of material and labor was about 10 per cent. higher than the average of the year before and after. Cost of labor on pile-driver: one foreman at $4 per day, six laborers at $2, two teams at $3.50; total cost of labor = $23 per day.

COST OF PILE DRIVING IN RAILROAD CONSTRUCTION.

No. of piles included in this report	4,400
" lineal ft. included in this report	109,578
Average length of piles	24.8
No. of days employed in driving	494
" lineal ft. driven per day	221.8
Cost of driving, per pile	$2.53
" " " ft	10.4 cts

Railroad Repairs.—The following are the data of pile driving for repairs to bridges on the Indianapolis, Decatur & Springfield R. R. The work was done from Dec. 21, 1885, to Jan. 5, 1886. The piles varied from 12 to 31 ft. in length, the average being a little over 21 ft. The average distance driven was about 10 ft. The hammer weighed 1,650 lbs.; the last fall was 37 ft., and the corresponding penetration did not exceed 2 ins. The hammer was raised by a rope attached to the drawbar of a locomotive—comparatively a very expensive way.

TABLE 26.

COST OF PILES FOR BRIDGE REPAIRS.

Items of Expense.	Total.	Per Pile.	Per Ft.
			cts.
Labor: Loading and unloading piles, 7½ days	$16 00	$0.08	0.4
Bridge gang, driving, 12 days	153.75	0.78	3.7
Engine crew, transportation and driving, 13 days	45.90	0.23	1.1
Train crew, transportation and driving, 13 days	71 50	0 37	1.6
Supplies: Engine supplies	23.40	0.13	0.5
6 pile rings and 2 plates	16.25	0.06	0 3
Repairs	11.04	0.05	0.3
Total expense for driving	$354.96	$1.70	7.9
Material: 4,192 ft. oak piles at 13 cts	$565.92	$2.68	13.5
Total cost	$900.89	$4.56	21.4

On the same road, 9 piles, each 20 ft. long, were driven 9 ft. for bumping-posts, with a 1,650-lb. hammer dropping 17 ft. The hammer was raised with an ordinary crab-winch and single line, with double crank worked by four men. The cost for labor was 3 3 cts. per ft. of pile, and the total expense was 21.8 cts. per ft.

Bridge Construction.—The following table gives the cost of labor in driving the piles for the Northern Pacific R. R. bridge over the Red River, at Grand Forks, Dak., constructed in 1887. The soil was sand and clay. The penetration under a 2,200-lb. hammer falling 30 ft. was from 2 to 4 ins. The foreman received $3 per day, the stationary engineer $3.50, and laborers $2.

TABLE 27.

COST OF LABOR IN DRIVING PILES IN BRIDGE CONSTRUCTION.

Kind of Labor	Pile bridge on land	Temporary bridge	Draw fender and ice breaker	Pivot pier	River pier
Preparation and repair of plant	$ 68.05	$ 63.65	$ 53.50	$ 37.00	$ 61.60
Driving	493.70	252.92	439.50	216.45	365.80
Sawing and straightening	78.75	.....	47.50	179.80*	131.90*
Total cost	$ 580.40	$ 316.57	$ 539 50	$ 432.25	$ 459.30
No. of piles in the structure	1,224	102	104	121	167
Tot'l no. of ft. remaining in the structure	7,258	3,710	7,023	1,639	7,316
Average length of piles remaining in the structure	32.3	.....	38 2	38.4	43.8
Average length of piles cut off	1.1	.....	4 1	6.6	3.7
Cost per ft. of pile remaining in the structure	8 0 cts.	8.5 cts.	7.6 cts.	9.3 cts.	10.4 cts.

Average cost for driving, per ft. remaining in the structure = 8.8 cts.

* Sawed off under 8 ft. of water.

† Including $70.25 for excavating and bailing in order to get at the sawing.

Foundation Piles.—The contract price for the foundation piles—white oak—for the railroad bridge over the Missouri River, at Sibley, Mo., was 22 cts. per ft. for the piles and 28 cts. per ft. for driving and sawing off below water. They were 50 ft. long, and were driven in sand and gravel, in a coffer-dam 16 ft. deep, by a drop-hammer weighing 3,333 lbs., falling 36 ft. The hammer was raised by steam power.

In the construction of a railroad in southern Wisconsin during 1885-87, the contract price—the lowest competitive bid—for the piles in place under the piers of several large bridges averaged as in the following table. The piles were driven in a strong current and sawed off under water, hence the comparatively great expense.

TABLE 28.

CONTRACT PRICE OF FOUNDATION PILES.

Material of Pile.	Kind of Driving.	Contract Price per Lineal Ft. For Part remaining in Structure.	Contract Price per Lineal Ft. For Pile Heads Sawed off.
Rock Elm.	Ordinary	40 cts.	15 cts.
Pine	"	40 "	20 "
Oak	"	48 "	25 "
Oak	Hard.	50 "	30 "

In 1887 the contract price for piles in the foundations of bridge piers in the river at Chicago was 35 cts per ft. of pile left in the foundation. This price covered cost of timber (10 to 15 cts.), driving, and cutting off 12 to 14 ft. below the surface of the water,—about 17 ft. being left in the foundation.

The cost of driving and sawing off may be estimated about as follows: (17 + 15) ft. of pile at 13 cts. per ft. = $3.90.; 17 ft. of pile, left in the structure, at 35 cts. per ft. = $5.95. $5.95 − $3.90 = $2.05 = the cost per pile of driving and sawing off, which is equivalent to nearly 7 cts. per ft. of total length of pile. In this case the waste or loss in the pile heads cut off adds considerably to the cost of the piles remaining in the structure. In making estimates this allowance should never be overlooked.

Harbor and River Work.—In the shore-protection work at Chicago, done in 1882 by the Illinois Central R. R., a crew of 9 men, at a daily expense, for labor, of $17.34, averaged 65 piles per 10 hours in water 7 ft. deep, the piles being 24 ft. long and being driven 14 ft. into the sand. The cost for labor of handling, sharpening, and driving was a little over 26 cts. per pile, or 1.9 cts. per ft. of distance driven, or 1 1 cts. per ft. of pile. Both steam-hammers and water-jets were used, but not together. Notice that this is very cheap, owing (1) to the use of the jet, (2) to little loss of time in moving the driver and getting the pile exactly in the predetermined place, (3) to the piles not being sawed off, and (4) to the skill gained by the workmen in a long job.

On the Mississippi River, under the direction of the United States Army engineers, the cost in 1868 for labor for handling, sharpening, and driving, was $3.11 per pile, or 20 cts. per ft. driven. The piles were 35 ft. long, the depth of water 15.5 ft. and the depth driven 13.6 ft. The water-jet and drop-hammer were used together. The large cost was due, in part at least, to the current, which was from 3 to 6 miles per hour.

The Popp System of Distribution of Power by Compressed Air in Paris.

At the recent meeting of the British Association for the Advancement of Science at Newcastle, Prof. ALEXANDER B. W. KENNEDY read a paper describing the system of distribution of power from a central station by means of compressed air which has been in use for some years in Paris.

He prefaced the description of the Paris system and his experiments upon it by a brief resumé of the different systems of distribution of power which are feasible, and the practical use which has been made of each.

Steam, water, air, and electricity seem to be the only four agents practically available for the transmission of power over long distances. All four have been used to a greater or less extent, and with more or less complete success. In England the distribution and use of high-pressure water has been carried out with the greatest engineering skill, and with correspondingly great success, by the Hydraulic Power Company in London and also in Hull. Electric transmission (in traction at least) has been at work on a small scale for some time in various places, and is about to be tried on a much larger scale under Mr. GREATHEAD on the Southwark subway. In America it has been very widely used for traction on tramways, and on the Continent it has also been used to a certain extent for power transmission for general purposes.

Steam has been used on a large scale in New York, but as yet its success does not seem to be unquestionable. Compressed air has of course been used over and over again in rough and uneconomical fashion in connection with tunnelling and boring work, but I think only two practical attempts have been made to utilize it economically and on a large scale for industrial purposes. Of these two, one has been made in Birmingham and the other in Paris. The Birmingham Compressed Air Power Company has established works on a very large scale, but various causes have unfortunately combined to cause delay in the commencement of its operations, which indeed are not yet fairly started.

Prof. KENNEDY then referred to a recent discussion as to the relative advantages of compressed air and water as mediums for the transmission of power, and said that in his opinion the two systems were intended to supplement rather than rival each other. He saw as little chance that air would take the place of water for elevators and cranes as that water would come into common use to distribute power for driving motors.

The plant for the distribution of power by compressed air in operation in Paris is by no means perfect, and the tests, which were made in July, 1889, were upon the plant then in actual operation, and no credit is given for the gain by improvements which are being introduced throughout the system.

The present system originated in 1870 as a pneumatic clock system, with a small central station in the Rue St. Anne. About 8,000 clocks in Paris are now driven from a station in the Rue St. Fargeau and regulated by a standard clock in the Rue St. Anne. Up to about two years ago a pair of single-cylinder horizontal engines and one beam engine were sufficient to supply the power for the air-compressors; but at that time the demand for air for running motors had so increased that six compound condensing engines were put in, each working two air compressors, and showing altogether over 2,000 I. H. P. This plant is now too small, and additional engines and compressors are being put in.

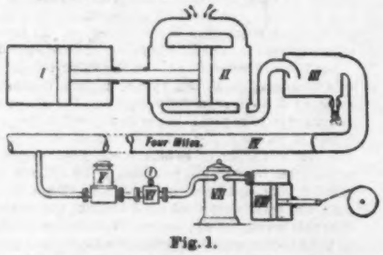


Fig. 1.

The general system of working is illustrated roughly by the sketch diagram, Fig. 1 [we reproduce this and the following cuts from a reprint of the paper in *Industries*.—ED.] which of course is in no way drawn to scale. It is as follows: The steel cylinders I, compress the air to a pressure of five atmospheres (six atmospheres absolute) or thereabouts in the compressor cylinder II. The air is drawn in direct from the engine house, where I found it to be about 70° Fahr., and after it has finally passed along the mains for some little distance, it is again about the same temperature. It is therefore of the greatest importance to prevent its temperature rising during the compression, as all heat so taken up by the air represents work done in the steam cylinders, of which no part whatever can be utilized. If the air were compressed adiabatically, that is, without any cooling whatever, its temperature on leaving the compressor would be about 430° Fahr., a temperature higher than that of saturated steam of 300 lbs. per sq. in. pressure. At St. Fargeau, water for cooling is allowed to run into the cylinders through the suction valve during the suction stroke in such quantity that the final temperature is only 150° Fahr. So far the result is satisfactory enough; but owing, unfortunately, to the particular way in which the cooling water is utilized mechanically, the air does not get cool until after it has been compressed, so that practically no benefit is obtained from the cooling in spite of the extent to which it occurs. The power expended, as we shall see presently, is practically equal to what would have been expended had the compression been adiabatic. The quantity of air dealt with at each revolution is 47.6 cu. ft. (for the pair of double-acting compressing cylinders) which is equivalent to 3.55 lb., the quantity of water used being about 2.4 lb.

After compression, the air, now having an absolute pressure of six atmospheres and a temperature of 150° Fahr., is pushed into large boiler plate receivers (III), of which some are arranged to act as separators, and in these a large portion of the cooling water, which has been carried along mechanically by the air, is deposited and removed before the air enters the main IV. The principal main is 300 Mm. (11.8 in.) in diameter and about ⅝ in. thick. It is of cast-iron made in lengths perfectly plain at each end, being connected by a very simple external joint made air-tight by india-rubber packing rings. This joint leaves the pipe quite free endwise, and also allows all necessary sideway freedom, so that accidental distortion to a quite measurable extent is entirely without effect on the tightness of the joints. The mains are partly laid under roadways and footways, as they would be in this country, and partly slung from the roof of the sewer subways. They are supplied at intervals with automatic float traps for carrying off the entrained water and the water of saturation which they deposit.

On entering a building on its way to a motor, the air is first passed through a meter (V) exactly as gas would be. The quantity passing is of course too great to allow anything like an ordinary gas meter to be used; indeed, only inferential meters seem to have been at all successful. The meter actually in use in Paris is a small double cylindrical box of external appearance as in the figure. The air passes by a branch through to the bottom of the inner box, up through it, down outside it, between the two boxes, and away through a branch at the bottom opposite the inlet branch. The whole measuring apparatus is a little four or six-armed fan, with aluminum or nickel vanes, placed near the bottom of the inner casing and communicating motion by a light vertical steel spindle to a clockwork register, like that of a gas meter, placed on the top. The quantity recorded is simply the number of revolutions made by the fan, or some proportional number, and this is turned into cubic metres by multiplication by an arbitrary constant, determined by direct experiment. As to the working of this meter, I shall have something to say later on; it is the only type used by the Paris company, and serves in a very large number of cases as a basis of payment.

After passing the meter the air is carried through a reducing valve (VI), by which the initial pressure in the motor is prevented from rising above a certain limit, which in practice appears to vary between 3½ and 5½ atmospheres absolute, according to the size of the motor in proportion to its work.

Between the reducing valve VI, and the motor VIII, there is placed in all ordinary cases a small stove or heater VII. This heater is simply a double cylindrical box of cast iron, having an air space between its outer and its inner wall. The air under pressure traverses this space, and is compelled, by suitably arranged baffle plates, to circulate through it in such a fashion as to come into contact with its whole surface. A coke fire is lit in the interior of the stove, and the products of combustion are carried over the top of it, and made to pass downwards over its exterior surface, inside a sheet-iron casing, on their way to the chimney flue. The heater for the motor on which I experimented (which indicated 10 to 12 H. P.) was about 21 ins. in diameter and 2 ft. 9 ins. high over all. The use of the heater, and the extent to which that use is advantageous and economical, are matters on which I shall touch later.

The motors themselves (VIII) used in Paris are mainly of two types. Up to 1 H. P. or thereabouts small rotary engines, of a form patented by M. POPP, are used; into the details of these it is not necessary to enter here. They start very readily, are easily governed, are provided with capital automatic lubricators worked by compressed air, run at a very high speed, and are altogether very convenient. They use the air with little or no expansion, without previous heating, and have, of course, no pretence to economy in use of air.

The larger sized motors, up to double-cylinder engines, 12 ins. by 14 ins., which is the largest size used, are simply ordinary Davey-Paxman steam engines, employed for air absolutely without alteration or modification. These engines have in most cases automatic cut-off gear controlled by the governor, and can therefore easily work with the largest economical ratio of expansion for the not very high available initial pressure. I believe that in every case heaters are provided for these engines, although in some instances, where both power and refrigeration are required, they are used sparingly, or not at all, in order to take advantage of the cooling due to expansion.

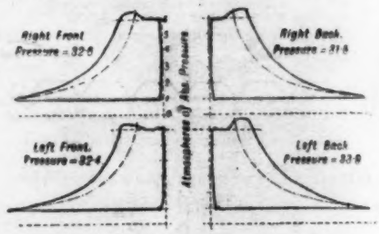


Fig. 2.

After this short description of the general arrangements of the Paris company's work I come now to the experiments which I made to ascertain its efficiency. Starting from the main engines at the central station, the particular matter which I had to determine was the I. H. P. which would be shown by a small motor three or four miles from St. Fargeau for each I. H. P. expended by the main engines on the air which passed through that motor. The ratio thus obtained would be the total indicated efficiency of the whole system of transmission. This ratio is in reality the product of a number of separate efficiencies, and the separate determination of these formed a necessary check on the valve of the total efficiency. These separate efficiencies may be summarized as follows:

1. Mechanical efficiency of main engines, or ratio of work done in compressors, to indicated work in steam cylinders.

2. Efficiency of compressors, or ratio of maximum work which could be done in a motor by each cubic foot of compressed air at 70° Fahr., to the work actually done in compressing that air.

3. Efficiency of mains, or ratio in which the capacity of the compressed air for doing work is reduced by friction and leakage.

4. Efficiency of reducing valves, or ratio in which the capacity of the compressed air for doing work is reduced by the lowering of its initial pressure at the motor.

5. Indicated efficiency of motor, or ratio in which the actual indicated work done falls short of the maximum work which the quantity of air measured through the meter could do after passing the reducing valve. The product of these five efficiencies is the total efficiency of transmission without the use of a heater. When a heater is used, the matter is somewhat more complicated. All the ratios given above represent what may be called mechanical efficiencies, all of them have unity for their maximum attainable value. It is therefore not possible to introduce in direct combination with them a thermodynamic efficiency (ratio of additional heat supplied to additional work done), which has for its maximum value not unity but 0.3 or some similar small

value. This could only be done if the measurement of efficiency had started originally from the heat given to the steam instead of from the I. H. P., and this would have given numbers having a minimum of practical value or convenience. Probably the best practical measure of the efficiency of the whole transmission, when using heated air, is obtained by finding the equivalent in I. H. P. at the central station of the coke used in the heater, and adding this to the I. H. P. actually used. It would not be possible, by the expenditure of this or any other amount of I. H. P. at the central station, to obtain the same results as by heating the air just before entering the motor, but that, of course, does not affect the question before us.

The determination of the I. H. P. of the main engines presented no difficulty. I measured it on one pair of engines at different speeds from 21 to 44 revolutions per minute. At 31.5 revolutions per minute it amounted to 254.9, and at all speeds it was approximately 8.1 I. H. P. per revolution per minute. The mechanical efficiency was sensibly the same at all speeds, viz., 84.5 per cent. There was no method available for ascertaining to what extent the real quantity of air delivered corresponded to the nominal volume swept through by the compressor pistons. The indicator diagrams (Fig. 2) show no signs of leakage past the valve, but there are no doubt various possible leakages which would not show on the diagrams. In the absence of any direct means of determination, however, I have assumed that the compressor cylinders delivered their full volume, which corresponds to 348 cu. ft.* of air per I. H. P. per hour. This air has a weight of about 25 lbs. It may be pointed out that the water injected practically fills up the clearance space at the end of each stroke.

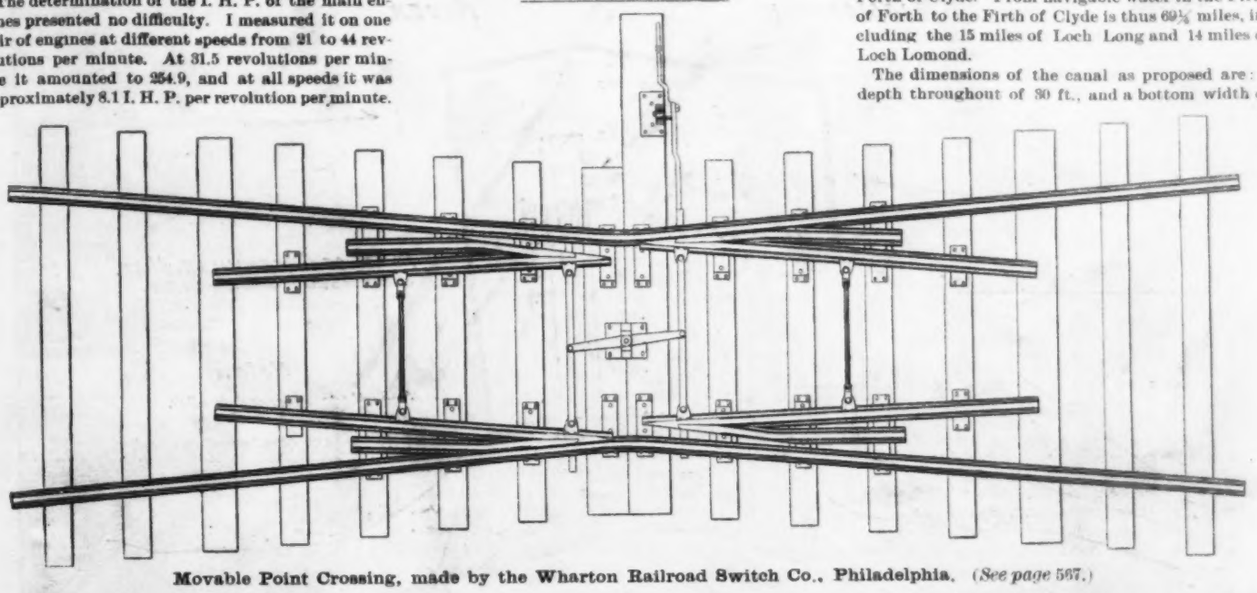
I have already pointed out that, at whatever temperature the air is delivered, it must fall to about its original temperature in the long length of mains before it reaches the motors. It is, therefore, a simple matter to find the maximum amount of work which can be done by the air delivered per I. H. P., for it simply amounts to the P V of the air at six atmospheres absolute and at 70° Fahr., plus the work it can do in expanding adiabatically to a pressure of one atmosphere, and minus the work necessary to expel it from the cylinder at that pressure and at the corresponding temperature.† In the present case I find that this work is equivalent to 0.52 I. H. P. for an hour, so that the efficiency of the compressors is 61 per cent. It will be seen from the diagrams that the compression curve falls only a little below the adiabatic, and as the area of the diagram is increased somewhat by the resistance of the discharge valve, the work is done practically the same as if the compression had been adiabatic, and there had been no cooling at all. This matter I have already referred to.

(TO BE CONTINUED.)

* Here and elsewhere, unless specially mentioned, volumes are supposed to be at atmospheric pressure and at 70° Fahr., the actual admission temperature during my experiments.

† In symbols, if suffixes 1 and 2 be used for the initial and final conditions of the air, if pressures be measured in pounds per square foot and volumes in cubic feet, the maximum work possible, without addition of heat, is

$$(P_1 V_1 - P_2 V_2)\frac{1}{1-1} = 3.45 (P_1 V_1 - P_2 V_2).$$



Movable Point Crossing, made by the Wharton Railroad Switch Co., Philadelphia. (*See page 567.*)

The Forth and Clyde Ship Canal.

From a report by Messrs. D. and T. STEVENSON, in the *Glasgow Herald*, the following further details are obtained of the proposed Forth and Clyde Ship Canal.

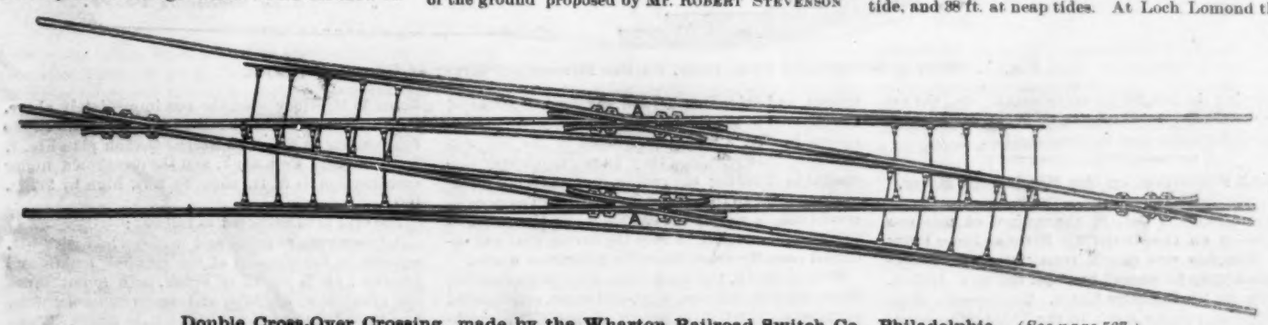
The first route examined was one covering much of the ground proposed by Mr. ROBERT STEVENSON in 1817, commencing at Grangemouth and following the track of the Forth and Clyde Canal to Bowling. It was found that the lowest ground on this route was 160 ft. above the sea-level for a length of about 13 miles. This would require a series of locks or hydraulic lifts and was not recommended.

Another route was through the Forth Valley, to Loch Lomond, thence to Tarbet, across a neck of land to Loch Long to the Atlantic Ocean. An alternative route is from Loch Lomond and through the vale of the Leven to the Clyde at Dumbarton; or third, across Lomond to near Arden, then by a 4-mile cut to the Clyde north of Ardmorehead. The surface of Loch Lomond is 22 ft. above the sea, and it has a water area of 21,000 acres, forming an ample reservoir for locks. This general route by the Forth valley is recommended in the report, but more elaborate surveys will be required to decide upon detail.

The distance would be as follows: From deep water in the Forth to the locks above Alloa, 10½ miles; from the locks to Stirling 3 miles; and from thence to Loch Lomond, 25 miles. Near the Lomond End would be a tunnel 2¼ miles long, through sandstone, which as proposed would be 102 ft. wide at water level and not less than 150 ft. high above the water. This can be made an open cut if considered advisable. The distance from where the canal joins Loch Lomond to Tarbet is 14 miles, and across the neck of land to Loch Long is 1¾ miles. Loch Long is 15 miles long to its juncture with the Forth of Clyde. From navigable water in the Firth of Forth to the Firth of Clyde is thus 69½ miles, including the 15 miles of Loch Long and 14 miles of Loch Lomond.

The dimensions of the canal as proposed are: a depth throughout of 30 ft., and a bottom width of 72 ft., and flat side-slopes where possible. The idea is to have locks only at the seaward ends, and these should be large enough to pass vessels 600 ft. long and 80 ft. wide, with smaller locks alongside for ordinary vessels.

The Firth of Forth would have to be deepened to 25 ft. at low tide from Grangemouth to Alloa, which would give a depth of 43 ft. at high-water spring tide, and 38 ft. at neap tides. At Loch Lomond the canal will debouch into 60 ft. of water. The report then goes on to deal with the railway and highway crossings on the line.



Double Cross-Over Crossing, made by the Wharton Railroad Switch Co., Philadelphia. (*See page 567.*)

The cost of the canal cannot be closely estimated until further surveys are made; but the Messrs. STEVENSON figure the Tarbet route at about $40,000,000, including interest during construction. The Ardmore route is put at an estimated cost of $43,750,000. The cost of management and maintenance is estimated at about $300,000 per annum.

Regarding the saving in distance by such a canal, the report gives the following table:

I. From the Clyde to the ports on the east of Scotland, northeast of England, and northwest of Europe, the distances saved would be about from 529 miles to 258 miles in the majority of cases, the distances being much more than halved.

II. From the Forth to ports on the west coast of Scotland, northwest of England, Ireland, America, and the Mediterranean, the distances saved would be from 487 to 141 miles; in all cases, except the American and Mediterranean route, the distances being more than halved.

III. Tyne ports to the St. Lawrence River, the distance saved would be 150 miles.

IV. West of Britain and northeast of Ireland to middle western ports of the continent, the distances saved would be from 377 to 98 miles.

The saving of distance, as illustrated in the table, in addition to the other advantages of the canal route after mentioned, will affect an enormous tonnage, and we show in the annexed table of tonnage, taken out from the Board of Trade's annual statement of shipping for the year 1888, the traffic which would have benefited by the canal that year. Shortly stated, the tonnage is as follows:

The traffic expected by the time the canal is completed is put down at about 9,516,000 tons, which, at an average rate of 1*s.* 6*d.* per ton of ship and cargo, should yield a revenue of $3,568,740 per annum. Deducting the $300,000 for maintenance, etc., the net revenue should be $3,268,740, or over 8 per cent. on the $40,000,000 required for construction.

Bank Protection on the Mississippi River.

In our issue of Oct. 26 the method of mattress revetment on the Mississippi River at Plum Point and Memphis was shown from "progress" photographs kindly forwarded by Capt. SMITH S. LEACH, United States Engineer Corps. The present illustrations of similar work in the Third Mississippi District give much more detail, and for them and the very satisfactory description of methods of construction followed, we are indebted to Mr. H. ST. L. COPPEE, U. S. Civil Engineer, of Greenville, Miss.

Fig. 1 shows a plan of a submerged spur dike at Greenville, Miss., as sunk in October last. Fig. 2 shows the crib No. 1 of this dike under construction. The bottom framework is finished and launched from the ways, and the first few layers of brush and poles, forming the pockets, is laid. This crib is lashed to mooring barges above and below by slip-lines. The same view also shows to the right the graded bank, on which the grading is done by means of pumps and troughs. At the left of the picture is seen the bottom frame of a part of the upper bank revetment.

Fig. 3 shows upper part of submerged portion of dike No. 1 as sunk, and the upper part of the dike under construction, and also the finished revetment.

For years the river front of Greenville has been caving away, necessitating periodical moving back of the houses, and in fact of the entire town, to avoid being swallowed up by the ravenous water of the Mississippi River. The old town just established after the war and before the bank caving commenced, was situated over a mile west of the present site. The intervening land is now occupied by the bed of the Mississippi River and at low water the Arkansas bank extends far over what was formerly the old Mississippi territory. In order to regulate this part of the river as well as protect the city front, the Mississippi River Commission commenced work in the fall of 1887, the plan being to stop the erosion of the bank by means of submerged spurs or sills located 500 ft. apart, resting on mattresses, and extending beyond the deepest water of the channel of the river. Ten dikes similar to that shown in Fig. 3 were constructed in the fall and winter of that year, and they have proven very successful in checking the caving, and restoring a permanent front to the city of Greenville. The present work (1889) is simply the extension, up the river, of this system of dikes, to stop the caving that has occurred recently above the other protection works.

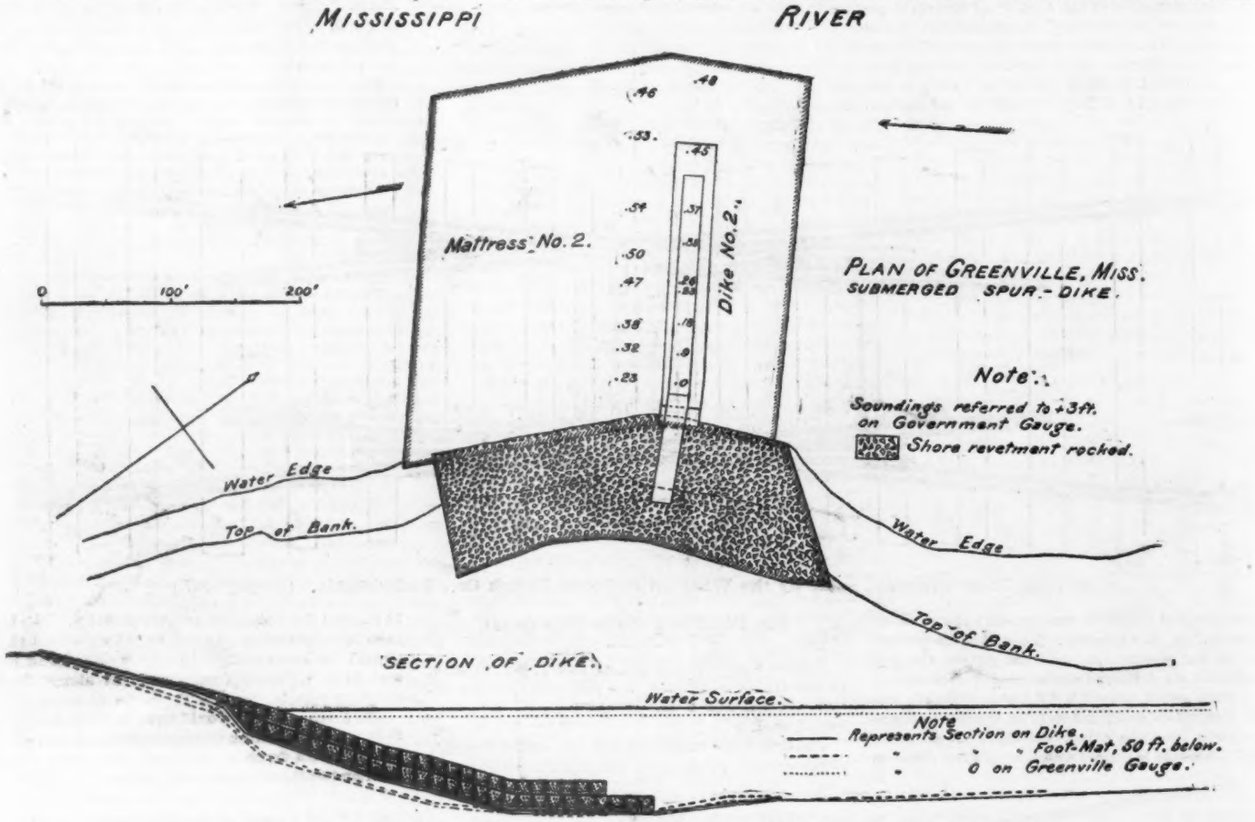


Fig. 1. Plan of Submerged Spur Dike, on the Mississippi River at Greenville, Miss.

More in detail, the work consists of cribs forming dikes, built of willows, wire, and stone, constructed at intervals of 500 ft. in length of bank and reaching out to beyond the deepest water in the channel of the river. The purpose they are expected to serve, as stated before, is the protection of the bank immediately at the point they occupy, and the indirect protection of the intermediate spaces by deposit, due to the eddy and dead water formed by their position out in the swift current of the river.

Each dike is constructed as follows: A site having been selected for the dike, and careful soundings having been made to show the profile of the bank and the distance to the channel, or in other words, an accurate hydrographical survey having been made of the locality, a mattress is built 250 ft. long, 200 or 300 ft. out into the river, as the case may be, to extend 50 ft. beyond the channel line. The mattress is constructed (on floating ways) of willow, brush and poles, wire and spikes, and as woven is launched off into the river. When finished and all afloat, and all necessary lines and cables are fastened to the shore, it is sunk into place on the submerged bank, with rock wheeled, and thrown from barges. The mattress acts as the foundation of the cribs which form the dike. The first crib is then constructed and sunk 50 ft. below the upstream edge of the mattress, and also extending out into the river beyond the deepest water, but not quite to the end of the mattress. The cribs are so built as to fill the inequalities in the profile of the bank, the top of the dike being finished with a uniform surface, if possible, and a slope of from 5 to 1 to 6 to 1, from river end to top of graded bank.

As a general rule, the crib is a right rectangular prism, the top one having a base of 16 ft., depth of 8 ft., and variable length, depending on conditions existing in banks and channel line. The next crib below is 32 ft. x 8 ft. by variable length, the next 48 ft. x 8 ft. and so on, each one below in the series being 16 ft. wider than the one immediately above. As a general rule, three cribs form the dike. In the dike shown in Fig. 3, as well as that on plan Fig. 1, but two cribs were sunk, and the one shown under construction is 32 ft. wide by 8 ft. high by 212 ft. long.

The crib is constructed as follows:

A framework of poles and willows laid with 8-ft. squares is constructed of the required length and breadth; on it layers of brush, both longitudinal and transverse, are laid, and again another frame, and so on till the crib is about 3 ft. in depth. These frames and intermediate layers of brush are thoroughly sewed together with No. 1 wire and 9-in. spikes, wire being left projecting far above the last frame to fasten the lower to the upper crib-work. Up to this point the crib is built on floating ways, but is now launched into the river at the points where it is proposed to sink it. It is fastened by lines to mooring barges, that hold it in place, and is also fastened to the shore by shackle lines (2-in. manila rope) leading well up the river, to hold it in position while sinking.

At the intersection of the frame, poles 8 ft. apart, upright posts 9 ft. high, are securely fastened, and to these as well as the lower frame the crib is built; pockets being constructed in each 8 ft. square, the shape of an inverted frustrum of a pyramid, by dropping back one pole as each layer is laid above the bottom frame. When finished the crib is 8 ft. deep, with pockets 8 ft. from center to center, each capable of holding 3 cu. yds., of rock. The whole crib, like the lower frame, is securely fastened

throughout with spikes, wire, and cables. After the crib is securely fastened to the bank by cables, having been placed over the desired location and after being checked up well by slip lines to the mooring barges, rock is thrown into the pockets until they are filled. When the weight has more than overcome the buoyancy of these structures, the strain on the lines is very great and the crib is in a sinking condition, then the slip lines are rendered slowly, care being taken to keep the strain uniform till the crib settles into its place on the bottom.

The next crib is built 16 ft. narrower and sunk in the same manner but on top of the first one, forming thus a sill 16 ft. high.

In some instances the spaces between two dykes, after a high-water season, have been found filled to a depth of 30 ft. with silt, large bars being formed in the eddies, thus very thoroughly protecting the bank.

The cost of an average dyke, complete, is about $10,000; this includes grading, mattress, revetment, cribs, etc.

The material used in building crib, shown in Fig. 2 is as follows:

228 cords of willow brush.
100 " " " poles.
324 tons rock.
3,200 lbs. wire No. 12.
2,000 " ⅝ in. wire cable.
300 " 6 in. wire spikes.
800 " 9 in. wire spikes.

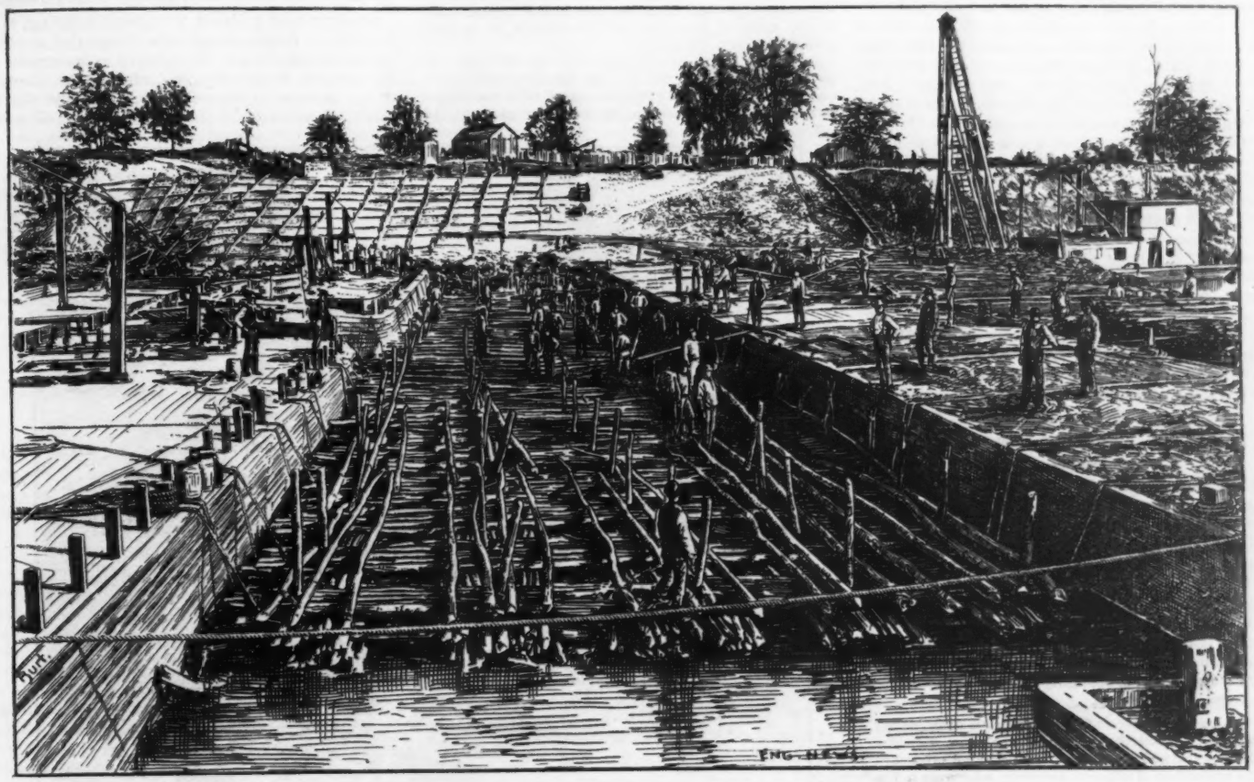


Fig. 2. Building Crib No. 1 for Submerged Dike at Greenville, Miss.

Generally before the mattress is constructed, the portion of the bank (at the site of the dikes) above the water is graded to a slope of 4 to 1 preparatory to covering it with a revetment of willow and stone, that should if possible be fastened to the submerged mat. The grading is done on extensive work by means of large hydraulic graders built for that purpose. But in this instance the earth is moved with shovels, the material being thrown into troughs laid on the required slopes (as a guide) through which a constant stream of water is forced from a pump on a floating pile-driver; thus each shovelful taken from the face is cast but once, and carried by the force of the water into the river. The cost of moving the earth in this manner is from 6 to 7 cts. per cubic yard, depending on the consistency of the material forming the bank, which ranges from loose, sandy loam to the toughest kind of blue clay and buckshot.

After the grading is finished, the revetment is laid. First a framework of poles with 8-ft. squares is laid, as shown in the views given, then two diagonal layers of brush are placed on the frame, then a corresponding top frame is placed on the brush, and the entire mass fastened together securely with wire and spikes. On this stones are laid so close as to hide the top layer of brush. Fig. 3 shows some of the finished revetment.

When the revetment is laid and mattress and cribs sunk, the upper end of the crib work is joined to the top of the bank as shown in Fig. 3. The construction of the upper portion on the bank is the same as that made in the water, the pockets being filled with stone as in the other.

The greatest item of expense in this part of of the country is the obtaining and handling of the necessary rock, also the very inferior, restless, migratory labor is a great source of trouble and expense. During the working season, or summer and early fall, which is very hot and sickly, it is almost an impossibility to keep labor of any kind or description.

The Water Front of New York.

The Dock Department investigation, so abruptly closed this week, had at first much to do with the revenue received from the rental of docks on the New York water front. The public ignorance of the real conditions governing the case, and the readiness of this public to accept "things as they appear," has doubtless led to some injustice in judging of the responsibility of the Dock Commission for all of the alleged irregularities of practice.

No pretence can be made here to explain the tangle of ownership, rights, and revenue; but some outline of existing conditions may aid the reader to judge for himself of the difficulty of administering the affairs of this complicated property. At one time, the city of New York is supposed to have owned the whole shore of the city up to 400 ft. above low-water mark, and its use was common to all. The titles to the properties are derived from Dutch, British, and New York State grants, and ordinances of the Common Council and acts of the Legislature, together with endless decisions of the courts, all have a bearing upon the validity of the title to these properties and upon their general control.

Parts of this shore were sold long ago to private parties, but under conditions very unlike those under which real estate generally is held. The nominal owner can only collect from his wharf certain wharfage fees fixed by the Legislature. The wharf is still public property, to the extent that it has been declared by the courts as practically a public highway, open to every one who chooses to travel over it.

In former times every vessel entering this port was met by the harbor-master, who assigned it to some dock; and the ship thus assigned was authorized to turn out any occupant it found there The harbor-master alone controlled, and favors, if granted, must come from him. No permanency of dockage was possible, as far as location was concerned; and for the same reason, no shedding over goods was possible or other protection than tarpaulins.

The multiplication of ocean steamers, their increase in size and in cargo handled, and the necessity for speed in loading and unloading, made the old condition of affairs unendurable. So, in 1875, the Legislature passed an act intended "to promote the public convenience," and permitted the leasing of certain piers for a term of years, and also allowed the erection of permanent sheds under certain restrictions. It seems, however, that the law failed to fully consider the knotty problem involved, and in many cases the private owners, and not the city, benefited by the passage of this law. More and wiser legislation is needed now to straighten matters out and to adjust the old law and precedent to the new conditions.

According to the last report of the Dock Department, the total gross revenue from leased wharfs and wharfage, in 1871, was only $315,524.54. The new law of 1875 seemed to make no abrupt and material change in this revenue, as far as the city was concerned, for the amount that year was $589,361, or about the sum due to the normal growth in value as shown by the receipts of the previous years. The income grew slowly, and stood at about $850,000 from 1878 to 1881, inclusive. But in the next year, 1882, under the reorganization of the city's affairs, the revenue suddenly advanced to $1,062,162. Since then it has steadily grown until it is now over $1,

400,000. The total revenue from 1871-1889 inclusive was $16,779,746, and the total expenditures in the same time were $14,847,553; showing a profit of nearly $2,000,000. One of the curiosities of this financial statement is the fact that back in 1871, in the "glorious régime" of Mr. TWEED, while the total revenue from this department little exceeded $300,000 the saleries paid the Commissioners amounted to $50,000. This latter item is now only $9,000 in the aggregate against nearly $1,500,000 revenue.

One of the serious questions to be considered in future legislation is whether these docks are to be leased for revenue sufficient for maintenance, extension, and repairs only, or whether the city is to derive a profit. As this water front was and still is practically public property, to be held for the benefit of the public, the past practice has decidedly inclined towards comparatively low rentals. Any profit, as turned into the City Treasury, would seem to be gathered at the expense of a class, the users of the docks, for the benefit of heavy real-estate owners rather than for the public at large; and it is held that the better policy would be to devote all revenue to the badly needed extension and improvement of the docks of this city. This latter position seems both more just to the interests involved and in better accord with the real ownership of this property. It is apparent to every one that the water front of New York is far behind the requirements of commerce and the rank of our city as a great seaport; but it will require many millions to put it in proper shape, and a thorough revision of existing laws must take place before this money can be raised or expended.

Expert Opinions on Fire Protection..

The *Boston Herald*, in an issue printed shortly after the recent serious fire in that city, published interviews with leading experts regarding the best methods of preventing such calamitous conflagrations. Mr. EDWARD ATKINSON advanced excellent ideas on the subject, some of which were referred to in our editorial in last week's issue. We abstract them more fully as follows, it being understood that the buildings referred to are warehouses and mercantile buildings, not the more expensive and more thoroughly incombustible office buildings.

1. Taking cognizance of the numerous examples of combustible architecture which are now standing throughout this and other cities, the principal safeguard for the protection of adjacent property whenever a fire occurs in one of these structures may consist in a roof hydrant service carefully planned, by means of which a great volume of water may be quickly poured into or upon the building which is on fire, or may be directed from a point of vantage for the protection of other buildings in close proximity. This roof hydrant service may be so devised as to be furnished with water from the city supply, or pipes might be laid from the dock; powerful steam fire pumps to be placed, under safe conditions, at various points throughout the district which is occupied by high buildings.

2. The only security which can be given to many of the badly constructed buildings now in existence is by stopping the fire at its beginning with automatic sprinklers.

3. In the construction of buildings, preference may well be given to brick, it having already been tried by fire. Granite is one of the most unsafe materials, being filled with hygroscopic water in the pores of the stone, which is converted into steam by moderate heat, thereby reducing the stone to sand and quickly destroying the bearing surfaces between the blocks by rounding off each corner of each separate stone. Marble is also a very unsafe material, being reduced by heat to lime. A good quality of sandstone may stand fire a little longer, but there is nothing equal to brick.

4. Cast-iron girders are absolutely unfit to use unless buried in concrete so that the heat of a fire cannot reach them. Cast-iron pillars are exceedingly treacherous, and may well be protected by any of the customary non-heat-conducting materials which are in use for that purpose. In some cases these posts have been made to support floor timbers on off-sets improperly designed, the timber having no bearing whatever upon the post itself. These cast-iron off-sets are very liable to be broken at an early stage of the fire, withdrawing the support from the floor above; in such event the breaking of one post is apt to bring down a whole structure. Buildings whose walls above the first or second story rest wholly either upon cast-iron posts and girders, or even on unprotected wrought-iron, may be considered very treacherous and unfit to be built, where any consideration is given to the danger of fire.

5. Aside from dangers within the warehouse itself, which may be guarded against in various ways, the chief hazard is in the windows, which, being quickly broken, open the way for the fire to attack the building from the opposite side of a street, or from adjacent premises.

With respect to ordinary warehouses, into which a sufficient amount of light may be brought by giving an equal or greater space to wall than to window, automatic shutters made of wood encased in tin may be placed upon trolley tracks either inside each room or sliding back into a space in the wall. These may be so arranged with fusible attachments as to close themselves by the heat carried through the glass of the window before the window breaks. There has been sufficient experience in the work of these fusible attachments to warrant this statement being made.

According to my experience, about one-fifth part of the actual losses by fire may be due to causes which cannot be foreseen and guarded against, with due regard to economy in construction. The other four-fifths are due to bad construction, want of protection, careless occupancy, and criminal negligence.

6. The slow-burning or factory construction will make a building very much safer from its own internal hazard, the advantage being that a fire cannot get into any hollow space where it may spread, fully protected from water. But when such a building is exposed to a danger on the opposite side of the way, which not only sets it on fire, but cuts off the access of the fire department to it, as in the recent instance of the Ames building, the slow-burning construction is no better than the ordinary combustible architecture.

7. When the slow-burning construction is adopted, great care is necessary in treating the heavy beams—not to paint them, as paint prevents seasoning; not to varnish either the beams or the ceilings, as the ordinary varnishes iguite from the slightest cause and spread a fire with extreme rapidity. They may be kalsomined or whitewashed, as the ordinary materials used in these processes do not stop the pores of the wood, and, to some extent, do retard ignition.

8. Projecting cornices of stone, hollow cornices, pitched roofs covered with slate, and other similar methods of combustible or dangerous architecture, are unfit to be used in the construction of any city building. The solid deck composed of thick plank of sufficient strength to bear any reasonable weight which can possibly be put upon it, is the only roof which ought to be tolerated on an ordinary building, each roof being separated from the next by division walls parapeted above, forming the standing ground for the firemen making use of the roof hydrant system, while the parapet would protect both them and the building from the fire, even in the next building.

9. Elevator wells should be covered by skylights, glazed with very thin glass, protected with wire netting. They should be constructed of incombustible material, guarded with wooden doors encased in tin, with a loosely fitted bull's-eye, through which the attendant may be able to see.

10. Special fire apparatus for inside use is of little value unless placed in the charge of a well-organized private fire department frequently drilled in the service. The roof hydrant system may, however, be placed under the supervision of the engineers now required in almost every large building, to be kept in order by them, but to be made use of almost wholly under the control of the public fire department. The pumps required may, however, be made use of for other purposes, in working low-pressure hydraulic elevators and the like, and might, when subject to such daily use, be more sure to be ready for the fire than if devoted exclusively to fire purposes.

Mr. ATKINSON declared that many buildings now standing in Boston ought to be designated as "super-extra-hazardous." He referred to the reports of Mr. JOHN R. FREEMAN on the efficiency of automatic fire shutters at the recent Lynn fire, and of the roof hydrant service at the Boston fire, as testimony of practical value as to the proper methods of protecting valuable buildings exposed by dangerous structures.

Reference was also made by Mr. ATKINSON to the plan advocated by him in 1880 and again in 1883 for the protection of the mercantile district in Boston by 5-in. stand-pipes at the street corners, supplying water to an efficient roof hydrant service.

Inspector of Buildings DAMRELL described the Brown, Durrell & Co. building which was burned as follows:

In its construction the building in question was of the regulation type. Its material was granite, the floorings being made of iron and hard pine. The structure was classed A 1, and complied with the law in every respect. The materials that entered into its construction are the same as those generally used within the building limits of our city. It is commonly thought that any structure composed of granite or other stone is perfectly secure from the action of fire. This is, however, erroneous. Granite, which largely enters into the construction of front external walls, is composed of crystalline minerals, honey combed with cavities in which are deposits of water, and when exposed to intense heat or flame an inflammable gas is generated which destroys by explosion the integrity of the stone. This results not only in razing to the earth what was intended to be a barrier to the flames, but it is a positive obstacle to the firemen as well, who are obliged to work at a disadvantage in the fiery hail of granite.

Mr. DAMRELL referred to the dangers of iron pillars and beams when exposed to fire, and commended hard-burned brick as one of the best and

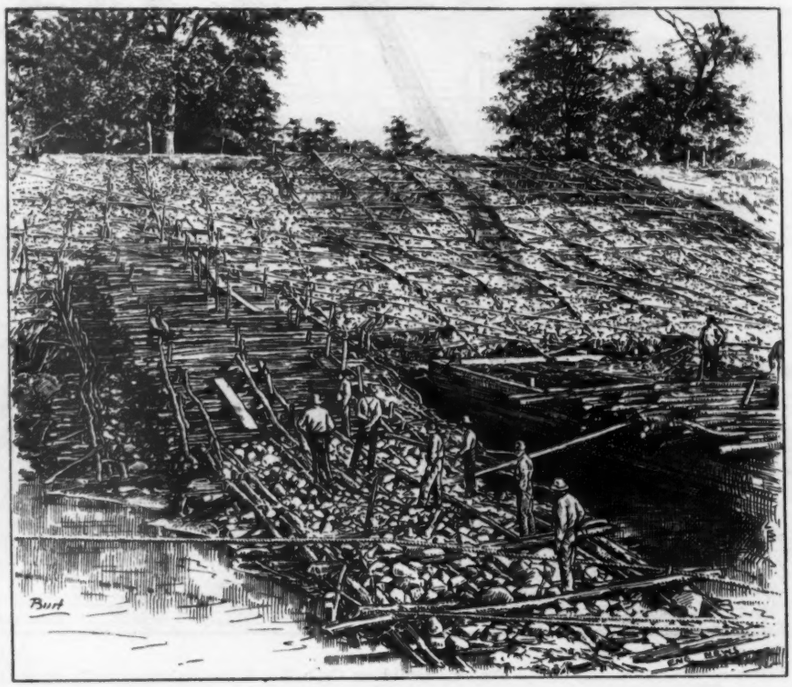


Fig 3. Finished Revetment and Dike under Construction.

safest of building materials. He proposed the following as a preventive of disastrous fires:

Make it impossible, under the law, to construct any building for the storage of inflammable merchandise, except on the condition that such building nowhere contains a floor area greater than 5,000 ft. or a cubic measurement of 60,000 ft. In the case of large buildings, this could be attained by a simple system of compartments made of brick partitions, of sufficient thickness to hold in check any fire that could originate within that compartment. We know that the amount of heat generated under any and every condition can be measured. We can also measure the rarification and expansion of a given amount of air, and thoroughly forecast its effects. It is clear, then, that by building in the way I have outlined with slow-burning—that is, fireproof—material, in sufficient quantity, we can hold in abeyance any possible blaze for a much longer period than is necessary, under present conditions, to enable our fire departments to reach the spot and assume control.

Fire Commissioner JOHN R. MURPHY, when interviewed, condemned especially the iron pillars in the Brown, Durrell & Co. building. With regard to the large floor areas he said:

The larger the floor area without substantial brick partition walls, arranged in compartment fashion, the greater the danger. The fireproof buildings should be fitted with these compartments to make them valuable as impediments to the progress of the flames. When I say fireproof I mean slow-burning, for I am of the opinion expressed graphically by ex-Chief GREEN, who, when some foreigner wrote him, asking him what fireproof structures Boston could boast of, replied: "One—the reservoir on Beacon Hill, and we're not quite sure of that."

Water Supply for Irrigation in the Island of Oahu, Hawaiian Group.

An interesting report has been received from civil engineers JAMES D. SCHUYLER and G. F. ALLARDT, who were commissioned to report upon the water supply available for irrigation in certain parts of the island of Oahu, Hawaiian Group, and also upon the practicability of establishing extensive sugar-cane plantations in the ranchos Honouliuli and Kahuku on the same island. These gentlemen make a full and interesting report with a map, and from it the following matter is abstracted:

While the minimum rainfall on Oahu is 24 ins. along the coast, and the maximum is 40 to 90 ins. on the mountain slopes, this rain is so unevenly distributed throughout the year that irrigation is essential to success in agriculture. Rice and cane require more water than any other irrigated crop, rice considerably more than cane. In Spain and India one cubic foot of water per second, in continuous flow, will irrigate from 25 to 35 acres of rice and from 45 to 65 acres of sugar cane. These are the limits given by all the authorities on the subject not only for the countries named, but for Algeria, Egypt, Italy, Japan and other portions of the globe where these crops are grown, and Messrs. SCHUYLER and ALLARDT find them substantially correct for these islands in the irrigation of sugar cane.

From data obtained from careful records kept by General Manager HUGH MORRISON, of the Hawaiian Commercial Company, at Spreckelsville, Maui, it was ascertained that in 1888, 2,094,000,000 cu. ft. of water (with a rainfall of 19.08 ins. in the period) irrigated 2,000 acres of caneland and 600 acres of *ratoon* or volunteer second crop. In addition to this 400 acres of seed cane were irrigated once a month, consuming about 70,000,000 cu. ft. of water. The remaining water was equivalent to an average flow of 64.18 cu. ft. per second through the year, which, divided among 2,600 acres, would appear to give an average duty of 40.5 acres per cu. ft. per second, and to indicate that the mean depth applied was nearly 18 ft. in the aggregate.

This seemingly low duty is explained by the fact that the main irrigation ditches supply water for all other uses on the plantation, for sugar-mills, steam-boilers, locomotives, steam-plows, and some 1,500 employés and the gardens of those who have them. Loss by evaporation and percolation in the ditches and reservoirs below the measuring weirs must also be considered. If all these were deducted, the average duty would probably be found to exceed 50 acres per cu. ft. per second. Mr. MORRISON's statement that his experience is that 11,000 cu. ft. applied every seven days will produce the best results, gives a duty of 65 acres. On these plantations a yield as high as 10 tons of sugar per acre has been secured in localities sheltered from the wind. The average yield of 1888, on 2,000 acres of cane plant, was 5¾ tons per acre. The *ratoon* crop averaged 3⅗ tons per acre. Further data are given for other cane plantations with a duty exceeding 55.5 acres per cu. ft. per second, and even as high as 85 acres on one plantation on Oahu.

The conclusions drawn by the reporting engineers are that the variation, due to the varying conditions of soil, climate, rainfall, wind, and exposed or sheltered condition, is generally between 40 acres as the minimum and 90 acres as the maximum duty of one cubic foot of water per second. Also that a greater duty than 60 acres cannot be counted upon with safety, as 328,500 galls. of water monthly per acre are needed, or to mature a crop, say 15 times that amount, or 4,927,500 galls. per acre.

A full investigation of the sources of water supply follows, much of which, however, is too local in its detail for general reading. The area of arable and irrigable lands in the properties examined is about 17,000 acres, with soil of exceptional quality, with about 14,000 acres of sugar-land. There are no living streams flowing immediately through this track; but storage reservoirs, fed by large water sheds and living streams, can be constructed, and there are natural springs of large volume near Pearl Harbor, and artesian wells are available. The springs burst out, with an almost phenomenal flow, from the foot of the low bluffs near the harbor, and the measured flow of unused water within a range of three miles, was 116.11 cu. ft. per second,—an amount sufficient to irrigate 7,000 acres of cane, with the possibility of increasing the flow so as to supply 10,000 to 12,000 acres.

The first artesian well boring on Oahu was made about ten years ago, and a good flow obtained at a depth of 273 ft. Since that date, over one hundred wells have been driven successfully. One of a group of four wells, in Honolulu, measured by Messrs. ALLARDT and KLUEGEL, showed a flow of 3.98 cu. ft. per second, or 2,580,000 galls. in 24 hours. The combined flow of the four wells was 10.58 cu. ft. per second. This artesian belt is confined to a marginal rim around the island extending from 21 to 42 ft. above sea-level. The deepest flowing well is 1,000 ft. in depth. The strata passed through in succession include, from the top—surface soil, coral, gravel (with some water) volcanic ashes and pumice, rock, water-worn boulders, ashes, volcanic rock, clay, water-bearing gravel.

An imaginary cross-section of the island is made up and shown from the data available. The conditions indicate that the island is surrounded by deep, thick strata of impervious clay or sedimentary formation, built up by slow deposit by the streams of the island in past ages. These strata seem to lap on the land to about the height indicated by the flow in the wells, lifted up by the gradual rise of the island above sea-level. These uplifted strata prevent the escape of the water into the sea beneath them and stores it up in the water-bearing rock.

The report concludes with elaborate estimates for pumping works and storage reservoirs, for which we must refer the interested reader either to Mr. G. F. ALLARDT, C. E. 410 California St., San Francisco, Cal., or to Mr. JAMES D. SCHUYLER, for engineering detail; or for financial information, to Mr. B. F. DILLINGHAM, Honolulu, H. I., who is the projector of the enterprise reported, and who will doubtless give full reply.

Specifications For Sea Wall.

The following is an abstract of the specifications for the construction of a sea wall on North Brother Island, New York, for the Board of Health.

The foundation is to be of rubble stone, well bedded and grouted with Portland cement. On this will be laid two courses of Greenwich, Conn., stone in straight courses; rock-faced joints cut back at least 12 ins., and with good level beds running through. This stone is to be of similar quality and color to that of the wall already built; it is to be not less than 4 ft. in length. Above these two courses the wall will be built in irregular courses with stone not less than 10 ins. square. This wall will have the joints cut back at least 6 ins., with good level beds, and at least one-sixth part of the stone is to be bond stone running through the whole wall. Upon this wall will be placed a cap-stone course. The wall will have a batter of 1½ ins. per vertical foot, will be laid in Portland cement, and after completion the joints will be raked out and pointed with Portland cement. At intervals of 30 ft. Mott's standard 4-in. cast-iron pipe will be built into the wall, the inner ends being protected by a pile of loose stones.

The wall will be backed up with good irregular rubble work of good building stone, fully bedded in and joints grouted with Portland cement. This backing up shall proceed as rapidly as the other portions of the wall and shall be well bonded to the outside walls. It will have a batter of 1½ ins. to the foot, and the back of the wall will be well plastered with a thick coating of Portland cement. The mortar will consist of best English Portland cement and sand, clean, sharp and free from salt and other impurities; to be mixed in the proportion of 1 of cement to 2 of sand, and no old or retempered mortar to be used.

Increasing the Firmness of Plaster of Paris.

According to a French authority, much of the inconvenience arising from the too rapid consolidation of plaster of Paris may be remedied by the simple addition to the mass of from 2 to 4 per cent. of marshmallow root, finely powdered. With this treatment it is found the plaster will not set for an hour at least; and, moreover, the mixture becomes so hard, on drying, that it may be sawn, filed, or turned, and in this condition is applicable to the manufacture of dominoes, dice, and numerous other small articles. If the addition of the marshmallow root be carried to the extent of say 8 per cent., the time of setting is still further prolonged, and the hardness of the mass of plaster, when cold, greatly augmented. Such a composition may also, while still soft, be rolled out on a glass tube, and thin sheets be produced, which possess the advantage of not cracking when drying, and which may afterward be easily detached and polished by mere friction. It is found practicable to incorporate colors with the mixture, and by this means good imitations of some kinds of marble are produced by careful manipulation; or the sheets or slabs may be painted upon when dry, and rendered quite impermeable by a process of polishing and varnishing, the appearance being thus rendered quite attractive, and all at a comparatively small cost.—*Providence Journal.*

The Manchester Ship Canal.

Admiral Sir G. H. RICHARDS, the acting conservator of the River Mersey, has submitted to the Conservancy Commissioners his annual report of the navigable condition of the Mersey.

The following passage refers to those portions of the Manchester Ship Canal Works which actually pass through the estuary of the Mersey and displace a portion of the tidal volume, thus directly or indirectly affecting the ebb and flow of the tidal current.

The canal enters the estuary 8 miles within the entrance, on the Cheshire shore, at a point just above Eastham Ferry. A straight training bank, 900 yds. in length, is in course of construction between the gates and the ferry pier, along which will be dredged a channel 600 yds. wide, to admit ships of moderate draught into the canal at low water at the lowest tides.

The flood of the canal was fixed at 11 ft. 10 ins. below the Liverpool datum known as "Old Dock Sill," that is to say, about on a level with the lowest spring tides, the outer embankment to be built solid to the height of 14 ft. 2 ins. above the same datum line.

Hence it follows that the canal will at all times be capable of containing a depth of water amounting to 26 ft. until it reaches the first series of locks at Latchford. The actual length of the canal which passes through the estuary is 13 miles 430 yds., but in several places the line passes either through salient projections of land, or is deflected within and above the influence of a 21 ft. tide, thus reducing the length of the embankments which actually pass through and displace tidal water to a distance of 7 miles 543 yds.

The amount of tidal water displaced in the estuary of the Mersey by the canal works is calculated at about 3¾ millions of cubic yards for a tide rising to 14 ft. 2 ins. or about 4½ millions at a tide of 21 ft.

A STEAMBOAT LINE on the Missouri River between St. Louis and Kansas City will be put in operation next season. The Madison, Ind., Shipyard Co. has the contract for the boats.

Elements of Weather in the United States of most Interest to Engineers, for the month of November, 1889.

STATIONS.	Temperature. Degrees Fah.				Wind velocity. Miles per hour.			Precipitation. Rain and melted snow. Inches.		
	Average	Max.	Min.	Range.	Average.	Max.	Direction at time of Max. Vel.	Total.	Heaviest in 24 hours.	No. rainy days
Northern Cities.										
Northfield, Vt.	35.8	58	12	46	7.6	36	N	3.45	.93	16
Portland, Me.	40.9	60	20	40	7.7	38	NE	7.95	3.40	11
New York City	46.9	65	27	38	11.1	37	SW	9.82	2.92	17
Pittsburg, Pa.	43.5	69	20	49	4.7	24	S	4.61	1.11	19
Chicago, Ill.	38.5	57	12	45	10.4	37	W	3.49	1.47	17
Omaha, Neb.	35.3	60	7	53	8.4	35	NW	0.87	.85	2
St. Paul, Minn.	29.5	56	*—4	60	6.8	26	W	0.97	.53	10
Duluth, Minn.	31.0	60	1	59	7.6	34	NE	0.87	.35	11
Bismarck, Dak.	26.4	63	*—12	75	8.0	48	NW	0.15	.15	1
Average.	36.4	60.9	9.2	51.7	8.0	35.0		3.58	1.30	11.6
Southern Cities.										
Washington City.	46.2	70	27	43	5.1	32	NW	3.06	1.57	16
Louisville, Ky.	44.9	76	17	59	7.0	32	W	5.99	1.65	16
St. Louis, Mo.	41.0	62	14	48	10.0	30	NW	4.43	1.50	11
Savannah, Ga.	50.1	83	29	54	7.0	32	NE	2.58	1.13	9
Leavenworth, Kan.	39.2	67	10	57	4.9	26	N	2.77	1.74	5
Jacksonville, Fla.	64.0	73	55	18	6.9	30	W	0.51	.46	3
Chattanooga, Tenn.	50.1	73	23	50	6.6	36	NW	6.44	1.74	19
New Orleans, La.	58.7	81	38	43	8.9	36	SW	2.18	.68	8
Memphis, Tenn.	48.4	77	24	53	7.7	36	W & NW	5.21	1.79	15
Palestine, Tex.	51.1	77	28	49	6.5	26	W	7.97	1 74	9
Average.	50.3	73.9	26.5	47.4	7.1	32.2		4.11	1.40	11 1
Western Cities.										
Helena, Mont.	31.4	54	12	42	4.6	30	SW	0.77	.56	6
Port Angeles, Wash.	43.3	60	30	30	3.2	17	W	3.20	.74	12
San Francisco, Cal.	58.6	77	47	30	5.9	34	N	2.90	.88	7
Salt Lake City, Utah.	39.0	61	26	35	4.0	30	NW	1.04	.28	6
Denver, Col.	32.4	60	3	57	5.4	34	NE	0.53	.21	6
Yuma, Ariz.	62.0	85	36	47	6.5	42	N	+T	+T	0
Santa Fé, N. Mex.	35.1	60	13	47	7.7	28	NE	0.45	0.23	5
Average.	43.1	65.0	23.9	41.1	5.3	30.7		1.27	0.41	6.0

*(—) minus sign indicates below zero. +T indicates trace of precipitation.

Railways in China.

According to the North China *Daily News* of Oct. 31, HUANG TI-FANG has convinced the Throne that the dignity of China demands that her railways shall be built with her own money. To this end ten per cent., which should amount to some $12,750,000, is to be set aside annually from the ordinary revenues of the Empire, that sum being supplemented by a fund to be raised from the sale of official rank, which is expected to bring in something like $1,200,000 a year. It is difficult to know under what heads the reductions are to be made that will enable it to be set aside; for the Chinese budget is not in the habit of showing a surplus, and it is always with great difficulty that any extraordinary demands, such as must occur almost annually in a great empire like this, are met. It is not considered likely that the Board of Revenue, of which WENG T'UNG-HO, the most determined opponent of railways, is president, will put itself out of the way to save money for this purpose.

The Hong Kong *Telegraph* had the following paragraph early in November:

Apropos of the proposed grand trunk railroad between Peking and Hankow, of which the Viceroy Chang Chih-Tung has been appointed Director-General, we hear that His Excellency intends to engage about a hundred trained Chinese mechanics from this colony to take up with him to Hankow for the purpose of taking charge of the railroad workshops, which will be erected at Hankow and Wuchang, as soon as the Emperor's decree has been received authorizing the laying of the rails. We also learn that Mr. TSAI SIH YUNG, the Viceroy's secretary, has written to a firm of commission agents in this colony for plans and estimates for three saw-mills, to be laid down at Hankow. It is stated that teakwood railway sleepers were at first intended to be used, and that a firm in Moulmein, Burmah, were communicated with upon the subject a short time ago, but the high prices demanded in the tenders will probably have a deterrent effect on the proposal, as we now learn that the officials are debating upon the feasibility of using Oregon pine as an alternative.

ROMAN PLUMBERS were either a little more particular than their brethern of the present era, or the authorities compelled a detail that would be now undreamed of with our short-lived water pipes. The Commission in charge of the improvement of the city of Rome has unearthed great quantities of lead water-pipe, each plainly stamped with the name of the owner of the house, the year of the plumbing, the name of the consuls for that year, and that of the reigning emperor. In opening 82 miles of new streets in that city, material has been found sufficient to add to our present knowledge a thousand details concerning the baths, heating flues, water-pipes, and house sewer-pipes, the organization of the police and fire brigades, etc.

PERSONAL.

Mr. LEAVENWORTH, City Engineer of Manchester, Va., has resigned.

Mr. EDWARD L. ROOT, C. E., died at Hancock, N. Y., on the 5th inst.

COL. BOONE, General Manager of the Zanesville, Mt. Vernon & Marion Railroad, has resigned.

Superintendent DONALD ALLEN, of the South and North Division of the Louisville & Nashville, has resigned.

Mr. T. H. DOBSON, Chief Engineer of the West Pennsylvania road, has resigned and will go South for the benefit of his health.

Mr. E. T. JEFFERY has been offered and probably will accept, so it is said, the position of Second Vice-President of the Chicago, Milwaukee & St. Paul road.

Assistant Superintendent DICKSON of the South and North division of the Louisville & Nashville will take charge of the Henderson branch.

Mr. GEORGE COWAN, a civil engineer, employed on the Canadian Pacific Railway, was run over by a Grand Trunk train at Chatham recently.

Mr. BENJAMIN NORTON has been elected Vice-President and General Manager of the Long Island Railroad.

Mr. T. D. KLINE, General Superintendent of the Mexican National road, will on Jan. 1 take the position of General Manager, vice Major O'BRIEN, resigned.

Mr. J. W. HARLOW has been appointed to fill the position of Superintendent of the Savannah & Western Railway & Banking Co. made vacant by the resignation of Mr. W. H. MCCLINTOCK.

Mr. JAMES E. MCNAIR, who for some years has been Superintendent of the Louisville, New Albany & Chicago at Monon, has been appointed Superintendent of the Ohio Falls Car Works at Jeffersonville, Ind.

Mr. JAMES BROWN, one of the oldest railway contractors in the State, died at Rochester, N. Y., Nov. 23. Mr. BROWN built a part of the Rochester & Buffalo road, now the New York Central, and until 1883 was for thirty years a roadmaster on the same line. In token of his long service, the company, in 1883, allowed Mr. BROWN to retire, and to draw the full pay of a roadmaster up to the time of his death.

Mr. G. J. AYCOCK has been appointed Master of Transportation of the Illinois Central road. He is also given charge of the machinery department of the main line.

Mr. JAMES D. CARSON, of Chicago, has been made Superintendent of the Louisville Southern.

Mr. L. B. JACKSON has been appointed Superintendent of Construction of the Chesapeake & Ohio, with headquarters in Cincinnati.

Mr. C. C. MALLARD has been appointed Assistant Superintendent of Bridges and Buildings of the Southern Pacific Line from New Orleans.

Mr. V. O. CASSELL has been elected City Engineer, of Portsmouth, Va., in place of Mr. THOMAS K. DWYER, deceased.

Mr. ANTHONY JONES, Chief Engineer of the Long Island Railroad, has resigned, after seven years service with the company.

Mr. JOHN W. HILL, the well-known hydraulic engineer of Cincinnati, O., has been appointed Chief Engineer, with the rank of colonel, on the staff of the new Governor of Ohio.

Mr. BYRON H. ELDRIDGE, C. E., of Chicago, Ill., was married to Miss NELLIE A. BIRGE, of Heuvelton, N. Y., at Chicago, on Nov. 26.

Mr. CHARLES ROCKWELL, General Superintendent of the Columbus & Hocking Valley road, has been elected President of the Superintendents' Association of Columbus, and also Chairman of its Executive Committee.

Col. S. H. LOCKETT, C. E., has returned from the United States of Colombia, where he has been engaged for the past year in examining and reporting upon certain engineering work in the interest of American capitalists.

Mr. GEORGE M. FARLEY, formerly Roadmaster of the Pennsylvania & Toledo Division, who went to the New York & New England as Engineer of Maintenance of Way, has been appointed Division Superintendent of that road.

The General Manager of the Pennsylvania Railroad has announced the promotion of Mr. W. B. MCCABE as Assistant Engineer of the West Pennsylvania Division, vice Mr. THOMAS H. DOBSON, resigned. Mr. J. K. JOHNSON has been appointed Supervisor to fill the vacancy caused by the promotion of Mr. MCCABE.

Mr. J. C. STUBBS, the new Second Vice-President of the Chicago, Milwaukee & St. Paul Railroad, has resigned his position with that company and will again assume the position of General Traffic Manager of the Southern Pacific road, at the request of the officers of the latter company.

Mr. THOS. WALKER, the eminent English engineer and contractor, famous as a builder of the London underground railways and as the contractor and engineer of the Severn tunnel, the Mersey tunnel, the Manchester Ship Canal, and other similar undertakings, died recently.

Mr. R. A. COWAN, Assistant Superintendent of the Madison Division of the Chicago & Northwestern railway has been appointed Superintendent, vice Mr. G. F. BIDWELL, who has been appointed General Superintendent of the Milwaukee, Lake Shore & Western Railway. Mr. COWAN has been with the Northwestern for twenty-four years, and was Assistant Superintendent for five years.

Mr. CLEMENS HERSCHEL, for the past ten years, hydraulic engineer for the Holyoke Water-Power Co., has resigned, and will go to Newark, N. J., where he will have charge of the construction of large waterworks besides his duties for the water-power company. Mr. HERSCHEL has been consulting engineer for many concerns, and has served on the State Railroad Commission.

Mr. B. H. EPPERSON, Superintendent of the Mobile & Montgomery division of the Louisville & Nashville, has been promoted to the superintendency of the L. C. & L. division of the road, with headquarters at Louisville. Mr. EPPERSON succeeds Mr. J. C. LOOMIS, who goes to the Chesapeake & Ohio as assistant to General Manager HARAHAN.

Mr. W. W. COLLINS, Superintendent of the Chicago, Milwaukee & St. Paul Ry., has been granted leave of absence for six months on account of ill health; during his absence Superintendent F. S. ATKIN will have charge of the Prairie du Chien and Mineral Point Divisions. Mr. R. R. MINTURN, M. Am. Soc. C. E., is appointed Acting Superintendent of the Northern Division during this interval.

CITY ENGINEER SPROATT, of Toronto, is still having some trouble with the faction of Aldermen opposing him. A late resolution to remove him from office was met by the suggestion that any reform in his office should be commenced by making his subordinates perform the work he now does himself, and better still, to allow only the Mayor and the Chairman of the Board to visit his office and "summarily eject every aldermen who went there to bother him."

Mr. HENRY S. CRAVEN, late Civil Engineer United States Navy, died at the Naval Hospital in Brooklyn on Dec. 7, of acute angina pectoris. Mr. CRAVEN

was a son of the late Rear Admiral THOMAS T. CRAVEN, and was for a time an Assistant Engineer in the navy, and was transferred to the Civil Engineer Corps on March 12, 1879. He was engineer of construction on the New Croton Aqueduct for some time, but was removed from office owing to want of harmony between himself and the Chief Engineer. He later returned to duty at the Boston Navy Yard and for sometime has been attached to the New York Navy Yard in charge of improvements going on there. He was 44 years old.

Mr. THOMAS A. WALKER, late contractor for the Manchester Ship Canal, died recently in London, aged 69 years. Mr. WALKER entered upon his profession in 1845, and for seven years was on the staff of Mr. BRASSEY. He then went to Canada, for Mr. BRASSEY, and was engaged on the Grand Trunk Railway and on the New Brunswick & Nova Scotia Railway. In 1864 he made a survey of the Vitebsk and Orel, and in 1865 a survey of the Nile from the first to the fifth cataract for Mr. CHARLES MANBY. He was manager of construction on the Metropolitan District Railway, being engaged on that work from 1865 to 1871. Shortly after its completion he built the East London Railway from the Thames Tunnel to Whitechapel. Among his later important works were: the railway from Dover to Deal, the Swansea Docks, and the Severn Tunnel. Mr. WALKER was an Associate of the Institution of Civil Engineers.

BOOK REVIEWS.

American Railroad Bridges.—By THEODORE COOPER. Engineering News Publishing Co. 1889. Large 8vo., 62 pp. with many folding plates. Price $2.00.

This reprint in book form of the excellent paper read by Mr. COOPER at the Seabright Convention of the Am. Soc. C. E. is intended to meet a demand for this data in a more handy form than that in which it was originally presented. One purpose of the paper is to show that the existing and accepted types of American railway bridges are the results of a true evolution; and to this end Mr. COOPER has given a most interesting sketch of the past history of bridge building in this country. This portion of the work has already been published in abstract in our issue of July 6, 1889, and it is only necessary to say here that this sketch commences with "The Great Bridge," a pile structure built in 1660 across the Charles River between Old Cambridge and Brighton, and continues down nearly to the first half of this century, noting the chief wooden bridges and the beginning of the metal types of structures.

While the historical portion of Mr. COOPER'S work is interesting and instructive, the real value comes in with that portion relating to the designing, proportioning, manufacturing, and erection of modern bridges, and the relative merits of typical American railway bridges. The credit for the first attempt to analyze the strains in skeleton bridge trusses seems to belong to Mr. SQUIRE WHIPPLE, the inventor of the Whipple truss, which is the prototype of the truss now most generally adopted in the United States. Mr. WHIPPLE published his thory in 1847, but it did not attract the attention that its merits deserved. Mr. HERMAN HAUPT followed, in 1851, with a treatise on bridge construction, but in his preface the author disclaims any knowledge of previous works on this subject, and his treatise was long a standard authority. These early explorers in an unknown theoretical field labored under the disadvantages of a defective knowledge of the calculation of strains in framed structures, and they were without sufficient data as to the strength of materials in the forms adopted for use in skeleton trusses, and entirely without information as to the effect of concentrated engine load.

The increasing use of iron as a material of construction made closer work necessary, and the gradually accumulating experience and tests of the materials used soon resulted in more elaborate theory and sounder practice. But until sometime after 1860 all parts of a bridge were still designed on the basis of a uniform load of one ton per foot of track. About 1870 this practice was modified by employing a somewhat heavier uniform load for the floor system than for the trusses; and the effect upon a bridge of the rapid growth of traffic and the constantly increasing weight of engines and cars was not fully appreciated until very recent times.

The paper then goes on to mark the stages of modern iron construction, pointing out the important influence upon practice of the investigations made, during the construction of the St. Louis Bridge, upon the strength and properties of bridge material and the testing of full-sized members and connections. In the building of the Cincinnati Southern Bridge, Mr. BOUSCAREN also made an important step forward in using an engine and train diagram for the live load, instead of the old uniform load, and in requiring that full-sized compressive members should be submitted to test to determine their ultimate strength and elastic limit. The Erie Bridge specifications, drawn up by the author in 1878, were the first general specifications covering the designing, proportioning, and detail of construction with a completeness that gave the railroad company the benefit of competition in construction and that yet assured certain fixed results in service. It was also the first specification or paper on bridge construction to entirely omit that relic of ignorance, "the factor of safety."

The treatment of equivalent loads, on the Erie basis, is considered, and the strength of materials and parts of skeleton structures comes next, the latter portion being chiefly historical. In connection with the manufacture of bridges, it is stated that there are now more than forty companies in America manufacturing railway and highway bridges, and it is estimated that these shops have a combined capacity equal to 200,000 tons per annum, or the equivalent of 80 miles of 100-ft. single-track railway spans. The typical American bridge-shop is described as to the arrangement of its several departments, the separate members entering into a bridge and their manufacture. The erection of bridges is treated in a chapter by itself, and many cases of specially rapid construction are noted; the last of these shows by successive photographs the erection of the two 518-ft. channel spans of the Cairo Bridge in 1889, with a total weight in one span of 2,055,200 lbs. The first span was swung in six days; and the false-works were then taken down, piles drawn and redriven under the second span, and the false-works again put up. The whole time covered by the erection of the two spans and change of piles and false-works, as described, was one month and three days, including five days lost in waiting for the completion of the masonry. The water was 20 ft. deep, and the false-works stood 104 ft. above water.

The typical American bridge is the pin-connected truss, only a few hundred feet out of an aggregate of 210 miles of railway bridges in the United States being of any other type. An interesting exhibit in this work is the amount and kind of railway bridges in the United States, as collated from the official reports of the State Railroad Commissioners. The double-track bridges are all reduced to single-track for the purpose of comparison and the summary for 60,000 miles of railroad reported shows 6,071,946 lin. ft. of bridges and trestles, or an average of about 100 ft. per mile of track. On this basis the 160,000 miles of railway in the United States would have about 3,030 miles of bridges and trestles. The failure of bridges is the subject of the last chapter, and the author believes that the report as to the number of such failures has been magnified and distorted, and gives his reasons for such belief.

An appendix includes a valuable abstract of recent tests on full size bridge members in a series of tables. Sixteen folding plates exhibit various types of wooden and early iron bridges.

PUBLICATIONS RECEIVED.

—*Annual Report of the Chief of Engineers U. S. Army.* 1889.

According to this report, there were 109 officers holding commissions in the Corps of Engineers, U. S. Army, at the end of the last fiscal year, exclusive of 26 more on detached duty. Our sea-coast defences are in the same inefficient condition that has obtained since the civil war, and their speedy improvement is again forcibly urged. The magnitude of the work contemplated in this direction may be judged from the fact that the completed projects for batteries, casemates and turrets for this purpose, exclusive of guns and gun-platforms, amounts in round figures to over $7,500,000 for Boston; $16,200,000 for New York; $3,600,000 for Hampton Roads; and $5,950,000 for San Francisco. An appropriation of $5,000,000 is asked for 1890-91 to commence work at the points named. The main part of the report is, of course, devoted to river and harbor improvements, but as this detail covers about 340 pages no abstract can be of value in the space at command. The Mississippi River Commission asks for $5,021,250 for the year ending June 30, 1891. Of this amount $4,000,000 is for the Mississippi River from the mouth of the Ohio to the Head of of the Passes. The Missouri River Commission wants $2,760,000 for improvements at various points. The plans and locations of 21 bridges over navigable streams were approved of in the year.

—*Report* of J. J. R. CROES, C. E., on the extent of the first works to be constructed for supplying water to Syracuse from Skaneateles Lake. New York, 1889. Engineering & Building Record, Printer.

This is practically a supplement to the previous report of Mr. CROES and treats of the capacity of the first works required for obtaining water from Skaneateles Lake. The initial supply is put down at 15,000,000 galls. daily, for reasons stated in full in this report. A series of tables upon the growth of population and the consumption of water in American cities will be found interesting reading.

—*Interstate Commerce Commission.*—Proceedings in the case of WM. L. RAWSON vs. the Newport News & Mississippi Valley Co. *et als.* Pamphlet. 16 pp.

The gist of the decision in this case is: "The amendment of March 2, 1889, has no effect on cases then pending. No order will be made to annul a tariff discontinued long before the complaint in reference to it was made."

—*Examinations: Their Uses and Abuses.*—A Lecture delivered at Queen's College, University of Melbourne, before the William Quick Club, by Prof. KERNOT, Melbourne, 1889. Pamphlet, pp. 24.

A very sensible paper, which we wish we could give space to republish in full, but from which we shall make some extracts.

SOCIETY PROCEEDINGS.

Engineers' Club of St. Louis.—A meeting was held on Dec. 4; Vice-President NIPHER in the chair; 31 members and 3 visitors present.

Mr. ROBERT MOORE submitted a report from the Standing Committee on Collection of Local Engineering Data. The information furnished the committee was of great and permanent value. Some data on "Fuels" was in preparation by Prof. POTTER, but had not been completed in time for this report. It was ordered that the committee be continued and requested to present a final report as soon as convenient.

The Special Committee on Nominations of Officers for the coming year reported as follows: For President, F. E. NIPHER; Vice-President, GEO. BURNET; Secretary, W. H. BRYAN; Treasurer, CHAS. W. MELCHER; Directors, E. D. MEIER and S. B. RUSSELL; Librarian and Manager, J. B. JOHNSON; Manager, J. A. SEDDON.

The report was accepted and the following additional nominations were made: For Vice-President, S. B. RUSSELL; for Director, F. H. POND.

Prof. NIPHER announced that Prof. T. C. MENDENHALL, Superintendent of the Coast Survey, would visit St. Louis soon; it was ordered that the President extend an invitation to Prof. MENDENHALL to address the club, also that the club extend to Prof. MENDENHALL a banquet while in St. Louis.

The annual reports were then presented from the Executive Committee, Secretary, Librarian, and Treasurer, the latter being referred to the Executive Committee to be audited.

On motion of Mr. ROBERT MOORE, the Committee on Fire Streams was discharged. On motion of Mr. SEDDON it was ordered that the Committee on Permanent Quarters be increased from three to five. COL. E. D. MEIER and Mr. GEO. BURNET were appointed the additional members of this committee.

Mr. N. W. PERKINS, Jr., then addressed the club on the subject of "Adding Machines." His paper treated particularly of the invention of W. S. BURROUGHS, of St. Louis, one of which was shown. A full description of the construction and operation was given. Separate parts of the machine were also shown, and its powers were demonstrated by a practical test. The subject was discussed by Messrs. ROBERT MOORE, W. W. PENNEY, ED. FLAD, GEO. BURNET, J. A. SEDDON, and M. L. HOLMAN. The machine was specially intended for use in banks, clearing houses, etc. It appeared, however, to be of limited use to engineers, whose work requires but little computation of this kind. Mr. HOLMAN stated, as his experience, that no calculating machine had yet been found to be of real advantage to engineers, from the fact that the problems considered were of so varied a nature, and the number of times which any given process had to be repeated, in identically the same manner, did not justify the use of mechanical devices.

WM. H. BRYAN, *Secretary.*

Iowa Civil Engineers and Surveyors' Society.—The second annual meeting will be held in the City Hall at Des Moines, commencing Friday, Dec. 27, 1889, at 2 P. M. All members are requested to be in attendance. Practising civil engineers and surveyors of this or other States are invited to be present.

SETH DEAN, *Secretary.*
GLENWOOD, Ia.

New England Railroad Club.—At the monthly meeting of this club at Boston on Dec. 11, the subject for discussion was "Railroad Signals and Signaling." Mr. R. H. SOULE, of the Union Switch & Signal Co., presented a paper on the subject.

Engineering Association of the Southwest.—The regular meeting was held at Nashville, Tenn., Dec. 12. A paper by Mr. EDWIN THACHER on "The use of the Slide Rule by Engineers and Architects," was read.

Liverpool Engineering Society.—The fifth ordinary meeting of the above Society was held on Wednesday evening, Nov. 27. Mr. F. HUDLESTON, Assoc. M. Inst. C. E., Vice-President, in the Chair. The principal event on the evening's programme was the adjourned discussion of a paper read on the 13th inst. by Mr. GEORGE FARREN, Assoc. M. Inst. C. E., entitled "The Stability of Earthwork and Masonry Dams."

Mr. FARREN first gave a brief resumé of his paper, and the Chairman then opened the discussion, which was continued by a large number of the members present, the majority of whom dwelt upon the advantages of gravity over circular dams. Mr. CHARLES H. DARBISHIRE read some interesting particulars, from an American source, of the "Mode of Construction and Cost of the Bear Valley Dam in America," which had been referred to in the paper. The whole of the speakers concurred with Mr. FARREN in his opinion as to the great stability of the Vyrnwy Dam.

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Coming Technical Meetings.

Western Railway Club, Chicago, Ill.—Next meeting, Dec. 17. Rooms in the Phœnix Building.

Engineers' Society of Western Pennsylvania.—Next meeting, Dec. 17. Secy., S. M. Wickersham, Pittsburg, Pa.

Boston Society of Civil Engineers.—Next meeting, Dec. 18. "Ventilation of School Buildings," Wm. E. McClintock. Discussion on "Ventilation." Secy., S. E. Tinkham, City Hall.

American Society of Civil Engineers, New York.—Next meeting, Dec. 18. Annual meeting, Jan. 15. Secy., John Bogart, 127 E. 23d St.

Engineers' Club of St. Louis, Mo.—Annual meeting, Dec. 18. Address of the Retiring President, E. D. Meier. "The Spreading of Contagious Diseases by Railways," J. C. W. Belcher, Secy., W. H. Bryan, 809 So. 7th St.

Engineers' Club of Philadelphia, Pa.—Next meeting, Dec. 21. Secy., Howard Murphy, 1122 Girard St.

Western Society of Engineers, Chicago, Ill.—Next meeting, Jan. 1. Secy., J. W. Weston, 78 La Salle St.

Engineers' Club of Kansas City, Mo.—Next meeting, Jan. 6. Secy., Kenneth Allen, 200 Baird Building.

Civil Engineers' Club, Cleveland, O.—Next meeting, Jan. 14. Secy., C. O. Palmer, 21 Cedar Ave.

New York Railway Club.—Next meeting, Jan. 16. Rooms at 113 Liberty St.

We comment at some length below on the general phases of the Dock Department investigation, but there is one particular phase which it seems to us that ordinary justice requires should be especially emphasized. Not without reason was it declared long ago that "Cæsar's wife must be above suspicion." The mere fact of investigation smirches the character of the most upright man, as of the most virtuous woman, under the best of circumstances, when there is every disposition to mete out exact and equal justice. When even the disposition to do justice is lacking, the more cruel is the injury; and it stands out upon the face of the record of this inquiry that there was not even the purpose to do justice by hearing both sides, while there was an evident purpose to iterate and magnify certain alleged facts which might look bad to the general public, but which engineers can see at once do not necessarily or probably imply the slightest irregularity.

Whether or not the real purpose of the investigation be, as is publicly charged, to make a "clean sweep" of the department, and more offices for Tammany, we do not know. A few days more will make this clearer. But whether this be so or not, and whether the investigation has reached everything that might be revealed or not, we deem it but simple justice to say that, after careful examination of the testimony so far taken, we find nothing which can fairly raise even a presumption against the integrity of Chief Engineer Green's administration of the Dock Department; and we may go further, and say that there is no engineer in the city of New York, and certainly no other person serving the city in any capacity, in whose integrity the great body of the profession would feel more confidence than in him,—a confidence which assuredly will not be weakened by the ridiculous collapse of the "charges" attempted against him.

Unfortunately, charges are apt to travel faster and farther than the knowledge that they have collapsed, as we have noted, but within the limits of the engineering profession at least, we deem it a duty to make an effort to prevent this. Our readers will bear us witness that we have not been slow to denounce official irregularities and malpractice whenever they occurred, when such denunciation seemed just, and we shall continue to do so. Should this Dock Department investigation ever be continued and ever show any genuine grounds for complaint as against the Engineer Department (it has shown such already as against the Commissioners) we shall not hesitate to make that fact as public as we now make the denial of it; but unless and until this is done we feel all the more bound to protect, so far as we may, the reputation of one who is high up on the short list of city officials who have a reputation worth defending, and who has, so far, been simply slandered by a sham investigation which condemns itself by its form at once and by its substance when examined.

In connection with our recent remarks on bridge floors and guard rails, and with the case of a broken axle on a Brooklyn Bridge cable car on Dec. 3, we call attention to the fact that there is a very dangerous piece of track on the Brooklyn Bridge railway. Just outside the Brooklyn station is a piece of iron viaduct or trestle, over which the incoming trains run at considerable speed, the cable having been released. The ties are not placed close together, and there is no guard rail of any kind, only a narrow plank spiked to the ends of the ties. Should a derailment occur on, or even near to, this part of the approach, one or more of the cars would almost certainly fall over either onto the roadway on the right or the promenade on the left, a distance of about 5 to 10 ft., the promenade and roadway being on an incline. Such an accident to a crowded train could hardly occur without very serious results. There is no reason why proper precautions should not be taken here before a disaster calls attention to their need. It is said that additional guard rails are to be laid on the bridge.

The *New York World*, for Sunday, Dec. 8, prints a rough perspective view of a bridge, and follows it with an extract from the *London Penny News*, describing the Forth Bridge. The statement that "the above view of this gigantic structure was taken from the South Queensferry end, and conveys a good idea of the grand engineering work," is a little absurd in the light of the fact that the bridge illustrated is the new drawbridge over the River Thames, at New London, Conn., U. S. A. A draw span, an American locomotive on the bridge, and an American tug in the water are added as helping out the illusion. Our progressive contemporary probably did not get the right cut out in time, and slipped this in with the idea that the common folks would not notice the change. And the readers of the *World* probably thought it was all right.

An interesting fact in regard to the solid floor bridges which we have been recently illustrating, is that the cost of some solid floor bridges of 28 ft. span, which leave the top as clear as an earth roadbed, was actually less than the cost for through plate girders. That these floors are destined to become increasingly popular, and that they will fully justify their existence when all the elements which should be taken into consideration are duly allowed for, seems to us too clear for doubt.

The Dock Department Investigation.

The investigation of the Dock Department of this city, which was brought to so abrupt and suspicious an ending this week, has been far from satisfactory to a public that supposed at the start that the Commissioners of Accounts had an honest and legitimate purpose in examining into the methods and administration of the present Board. If the commissioners had any such purpose, Corporation Counsel Clark, who was the active agent in this investigation, has pursued a method of getting at the information sought for which must appear unfair and misleading.

We are not inclined to defend the Dock Commission, for if the investigation proved anything at all, it was that as a body they performed their duties in a very loose manner, and were anything but alert in looking out for the public interest. But we do take a decided interest in the conduct of engineering affairs in that department, and protest against the outrageous methods of examination by which the public was adroitly led to believe that there was inefficiency, or even worse, in the engineering staff of the department.

The plan of examination adopted by the Corporation Counsel was most questionable, and seemingly purposely selected to confuse and if possible criminate the witness. It was wholly one-sided, insomuch that Mr. Clark did not so direct his inquiries as to obtain full information about the subject in hand, but those questions were selected that were best adapted to put things in their most unfavorable light, and when the witness had been badgered into answering in a manner that, without a specific charge, left the case open to the darkest suspicion, he was abruptly stopped, and another and entirely different line of examination taken. The witness was without counsel, he was utterly unprepared as to the line of examination, and was not permitted to explain circumstances, conditions, ruling, precedent, or office policy. Any such explanation of the engineering irregularities "discovered" would have cleared away the clouds of suspicion cast upon them by the Counsel. If the purpose of Mr. Clark was to befog press reporters, and through them the public, and to build up a structure of charges carefully planned by him in advance, he was eminently successful.

MINOR STRUCTURES, CANADI

FROM PLANS FURNISHED BY E. P. C. GIROUARD.

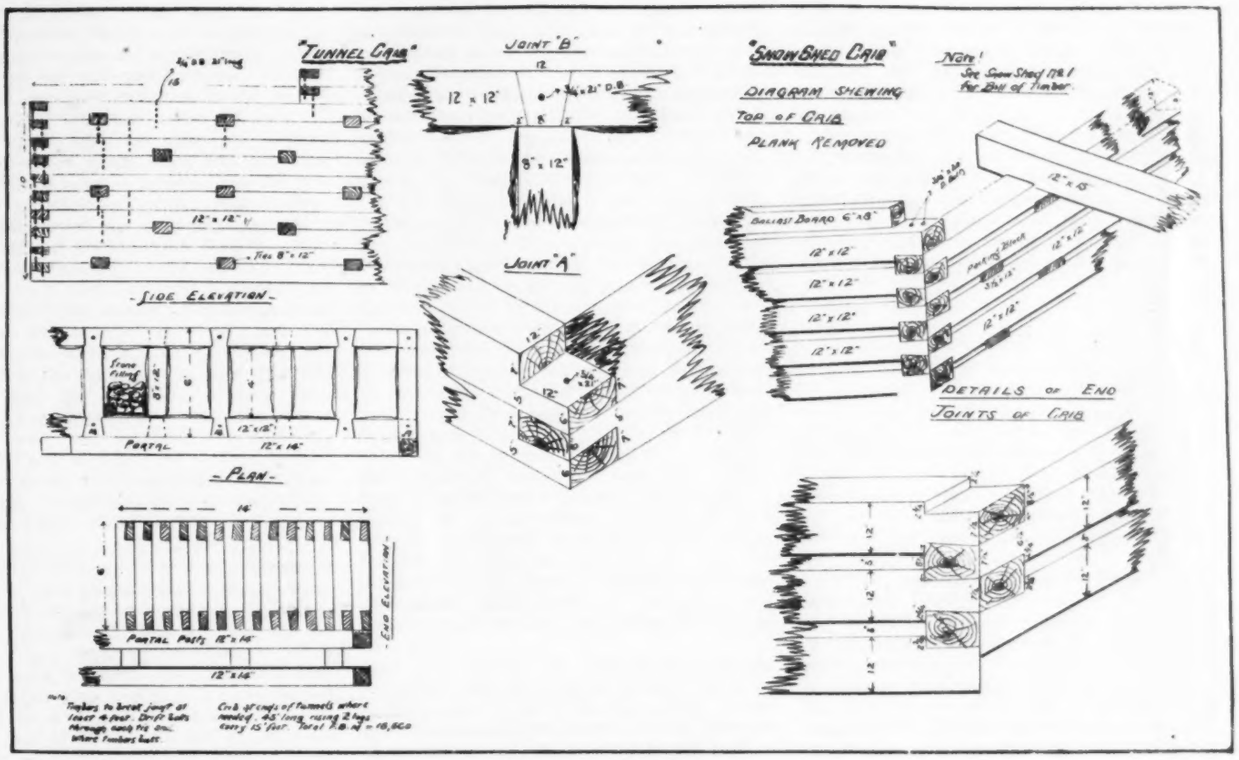


FIG. 1. CRIB-WORK.

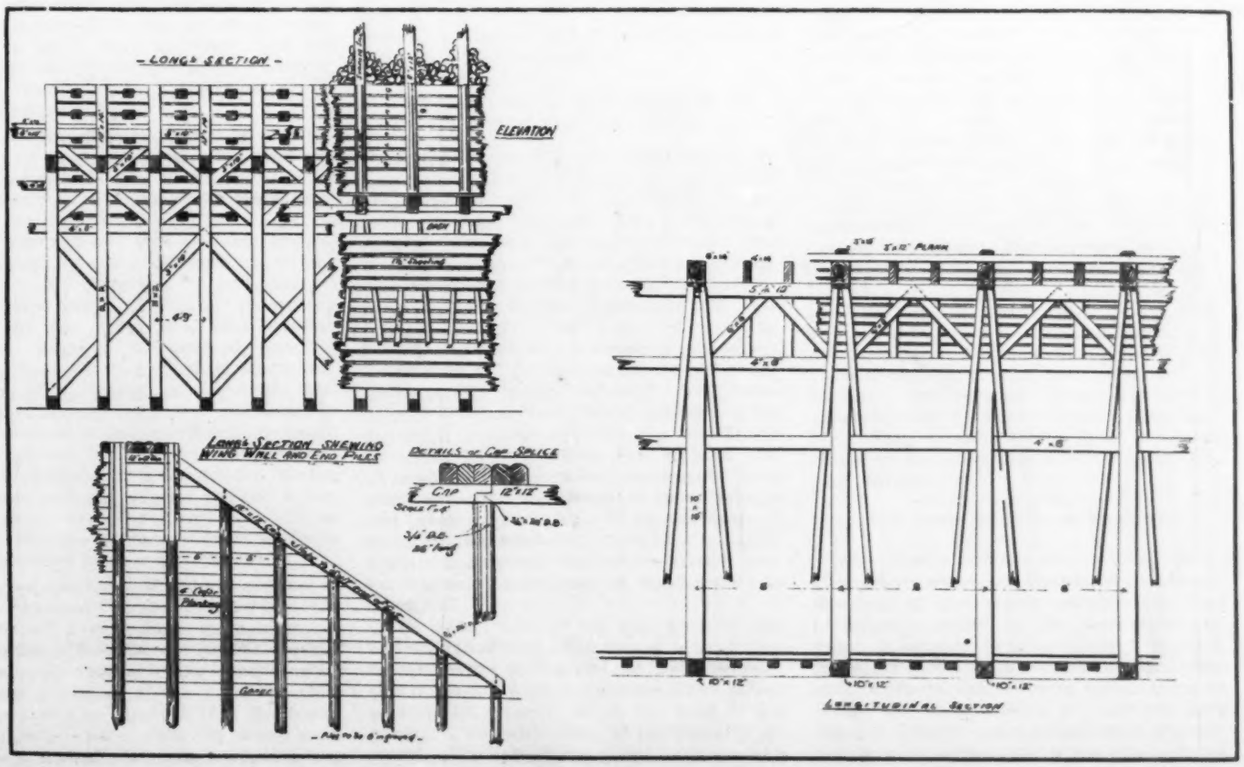


FIG. 3. SNOW SHEDS.

...S, CANADIAN PACIFIC RAILWAY.

...D BY E. P. C. GIROUARD, ASST. ENG. INT. R'Y OF MAINE.

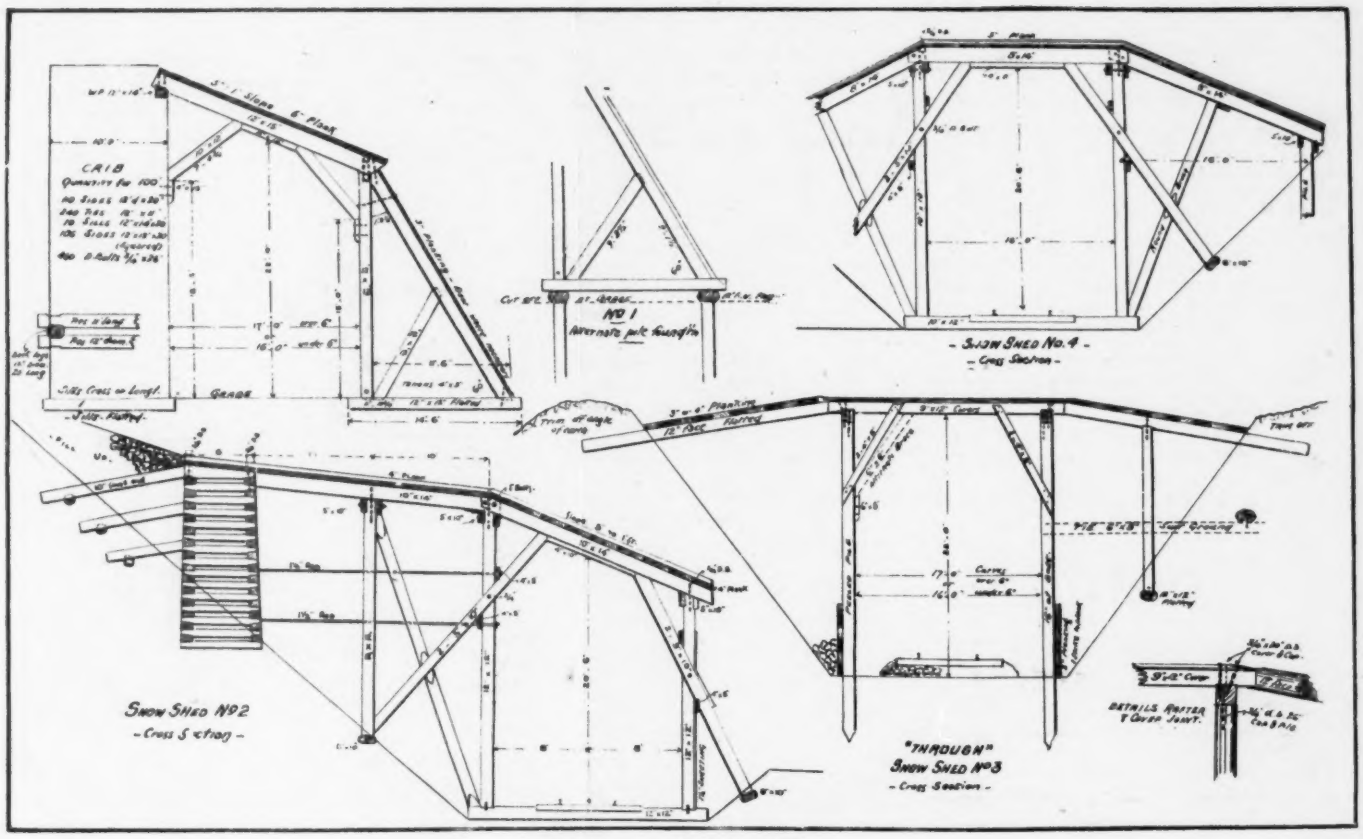


FIG. 2. SNOW SHEDS.

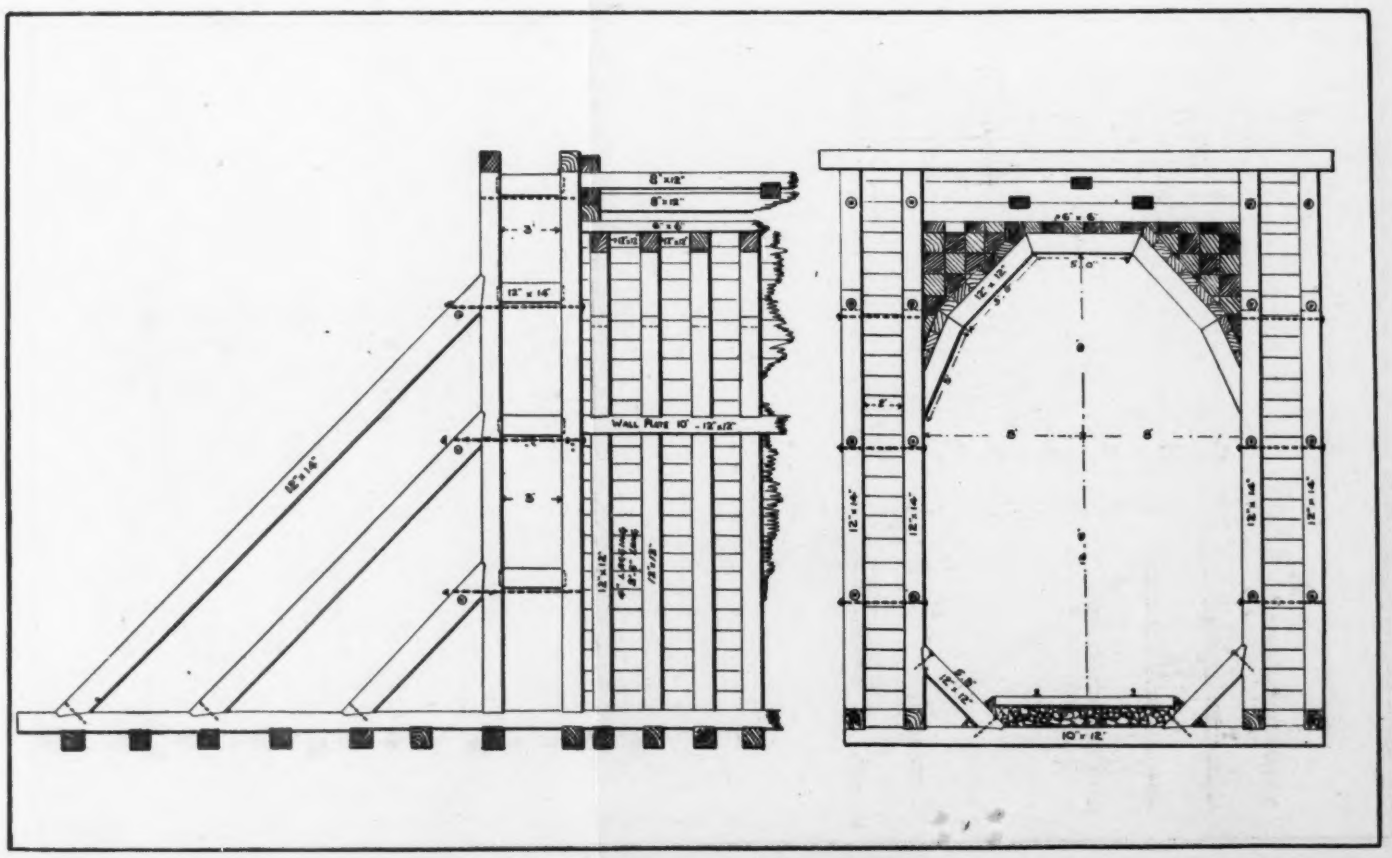
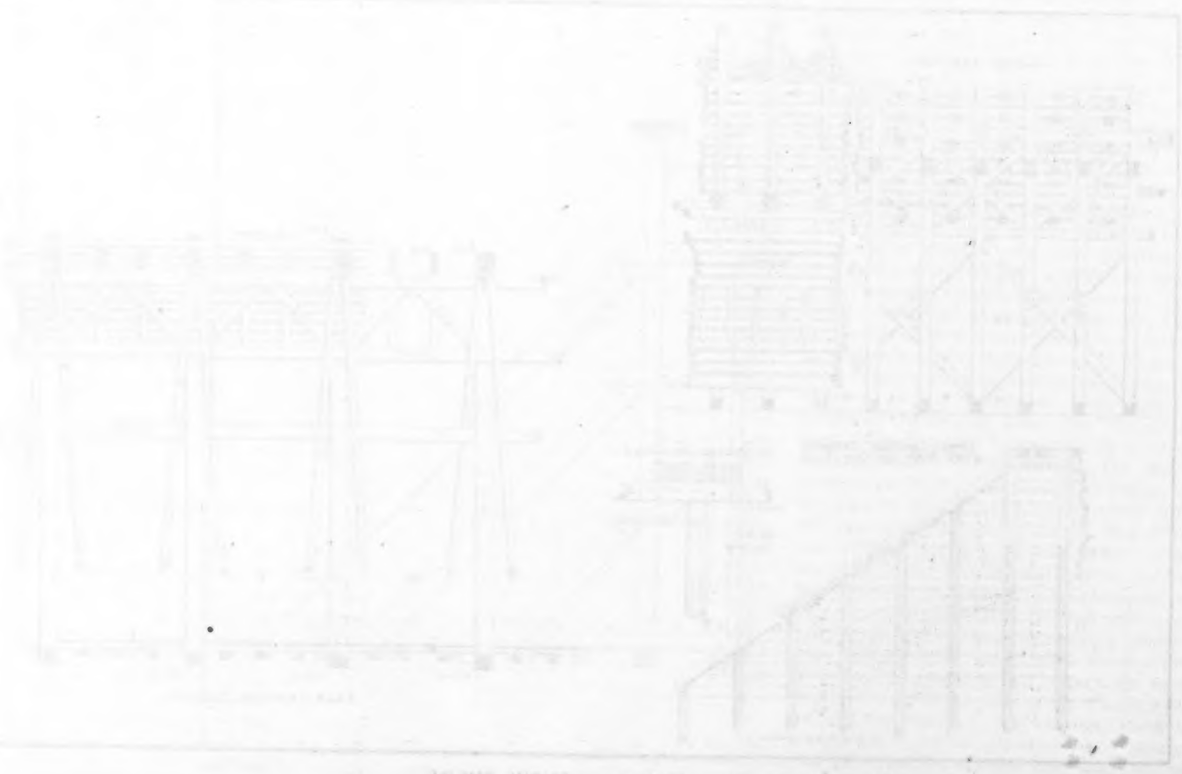


FIG. 4. TIMBERED TUNNEL PORTALS.



As an example of what we mean, we will take the case of the dock on the Harlem River, which by its failure was made "to prove" the lack of engineering skill in the Chief Engineer. The dock did fail, but the witnesses were not permitted to explain that it was but a temporary structure, placed on yet undetermined warden lines, and purposely designed to be easily removed when the time came for such removal; that it took the place of a deep timber crib which would have cost more to build and much more to remove than the pile and crib structure adopted; and finally, that the failure was not due to the engineer's plan at all, but to the fact that the rear rip-rap wall, designed to be carefully put in with 1 to 1 slopes in such a manner as to protect the piles against thrust, was carelessly built with a steep river-slope, and was thus unable to stand against the push of the inside filling put in later. It may be fairly charged that the inspection during construction was insufficient; but the Chief Engineer was not the inspector and his plans were not at fault. As a proof of the latter statement, other temporary bulkheads, built by the department on the same plans, stand with a very slight bulging.

The settlement of certain portions of the river-wall is also made the foundation of a charge of poor engineering, a charge magnified to enormous proportions. The Corporation Counsel carefully avoided the admission of any testimony tending to show that this wall, in parts, was built over mud 150 ft. or more deep, and that to have carried this wall to a firm foundation by ancient methods would have entailed expenditure out of all proportion to the purpose in view. This wall, supported on vertical and inclined piles and a rip-rap of wide base, was the design of Chief Engineer GREEN, and he was especially commended at the time, by engineers whose long experience enabled them to appreciate the difficulties overcome, for his ingenious and economical plan for bridging over these soft mud bottoms. In their case a vertical settlement was provided for, and in many cases expected; and the remedy was simply the addition of another course of granite where it was most easily applied, that is, on top.

That these two charges practically cover all the faults of engineering which the Corporation Counsel picked out of fifteen years of continuous service as engineer of the department, seems very much like proof that it was only with difficulty that he found ground for complaint at all. We give no weight whatever to the testimony of an employé of the lowest grade, discharged for drunkenness over six years ago, who testified as to the dumping of dredged material back into the dock from which it was taken. While any such rascality proven would seriously reflect upon the alertness and administrative efficiency of the Chief Engineer, sworn testimony of the kind quoted unhappily can always be obtained for a few dollars, or even to satisfy a personal grudge against a former employer. Had this charge been true, no doubt additional and more weighty evidence would have been at once brought out.

The forced admission of one witness, that at times he "guessed" at the quantity that was to be dredged from a dock, in making out his preliminary estimate of "probable quantities," was so twisted by the examining attorney that a number of the press reporters understood, and so reported, that the dredging companies were paid on guess-work quantities. No mention was permitted that the contract and specifications on which this, or any other, work was let specifically stated that the contractor "admits and agrees" that "the amounts and quantities of materials to be furnished or work to be done, as stated in the proposals for estimates for said work, are approximate only, and that he has judged for himself as to the accuracy of such estimate and statement." The method of measurement of the material after it is dredged is plainly described in these specifications as carried out. No engineer need be told of the material difference between a preliminary estimate and a measurement of pay material.

The testimony relating to the rental of dock property, besides being somewhat foreign to the purpose of this present comment on methods of investigation, was so imperfectly handled, as far as the real conditions controlling this rental were concerned, that its only value, though a sufficient one, was to show that there was work for the Legislature to do in remodelling the entire administration of the city's water frontage. The wharf property of New York as now held is an exceedingly knotty and difficult subject to understand; and one not at all adapted to a one-sided examination, if the powers and duties of the Dock Commissioners and their actual responsibility for the condition of affairs alleged, were to be honestly and thoroughly sifted. On another page our readers can form for themselves some idea of the difficulty of disentangling this problem of control of and revenue connected with the water frontage of New York.

As first stated, this investigation simply does not investigate; and if current rumor be correct, that under it lies a purpose to promote the interests of a faction at the expense of individual reputation, we can only deplore the condition of our body politic which would permit such an outrage. It is difficult, if possible at all, for a man of the most unblemished character to entirely remove from the public mind the suspicions sown in investigations conducted as was this. To the engineer especially, his reputation as an honest and experienced man is his sole capital, and to blast this or to injure it in the slightest degree, without just cause and full proof, is morally worse than highway robbery.

Civil Engineers vs. Line Officers in the Bureau of Yards and Docks.

The last Annual Report of the Chief of the Bureau of Yards and Docks, of the United States Navy, is before us: and while it is an excellent report generally, there is one recommendation in it against which we must protest, in the name of the engineering profession and for the general good of the Government. Chief of Bureau WHITE says that it is "very necessary" that a *line officer* of the navy be detailed as his assistant, and urges for this officer the highest pay of his grade while serving in that capacity. This same document reports that the expenditures of the bureau upon yards, stations, etc., was $1,547,150.51, for the year ending June 30, 1889. Out of this total $999,966.89 was spent upon "yard improvements," and $312,646.87 upon "repairs and preservation." This is an aggregate of $1,312,613.76 expended upon works of a purely engineering nature: and the estimated cost for the present fiscal year of similar work is $1,308,755.

The great bulk of the real work of this bureau is thus very evidently of a kind that belongs to the province of the civil engineer; and it is a civil engineer and not a line officer who should properly be at the head of this bureau, if its work is to be intelligently directed. The line officers of our navy are, as a class, perhaps, better educated and better trained, so far as a navy without ships will train them, than officers of a like profession among European nations; and the publications of the Department and the proceedings of the Naval Institute bear witness to the value of their labors in the direction of improvement in ships and armament. But in this training, civil engineering plays a very subordinate part, and of valuable experience they have none.

Submarine construction of the most difficult character, such as is now in progress in Brooklyn, and is very generally the characteristic of the work the Bureau of Yards and Docks is engaged upon, is only taught in the broad school of experience; and it is this experience and practical training alone that make the opinions and plans of the engineer valuable. It is certainly not in accordance with the fitness of things to put at the head of a department, spending almost one and a half million dollars annually upon strictly engineering works, an officer who knows nothing about civil engineering. And the matter would only be made worse by appointing as the chief assistant of this head of the bureau another line officer, like his chief in the one respect that neither is fitted to pass an intelligent opinion upon the merits of plans which nevertheless require "their approval" before they can be executed.

Foreign nations manage this thing differently; and England, with all her traditions and sinecure offices, puts engineers in charge of her public works of all kinds. The present organization of our Bureau of Yards and Docks is only a survival and a tradition: and it would be quite as sensible to put a line officer in charge of the later Bureau of Steam Engineering as to make him officially responsible for the work of the civil engineer.

"Every man to his trade" is a homely saying that should apply to government as well as to private occupation; and office to the man best fitted to fill it should be equally applicable in this case. The engineer now does all the work that is of any real value to the Government, and this work would be enhanced still more in value if the engineer was enabled to consult with the best and most experienced man in his own professional corps, as his chief, rather than with an official who cannot, and does not, have any sympathy with him in the matter under discussion and is not in possession of the experience necessary to appreciate suggestions or to assist in the solution of knotty problems

And lastly, but by no means less worthy of consideration, is the fact that whereas the law governing this Bureau distinctly says that "there shall be a civil engineer at the Bureau," no such officer has been detailed there for duty for years past. With many millions to be spent in the near future upon new navy yards, works demanding the highest grade of civil engineering knowledge and experience, the present organization seems painfully absurd; and it should be the duty of the Navy Department to make a speedy change in the interest of common sense and good government.

The Howe Truss Strut Problem.

This "ever charming, ever new" problem, of which correspondents have given elaborate solutions in our recent issues, is one that periodically comes up for discussion, and which is usually considered from a theoretical rather than from a practical point of view, or in a general rather than a special manner. While we do not desire or intend to give space to further communications on the subject, we may perhaps say a few words on the subject ourselves.

There is given a rectangle whose height is a and whose width is b, and it is required to inscribe within it another rectangle whose breadth is c and whose length is x. What is the value of x in terms of a, b, and c? Such is the general problem, in which no restrictions are placed upon the value of a, b, and c. The special problem, however, is that in which the given rectangle is a panel of a Howe truss, where b is sometimes nearly equal to a and rarely or never is less than $\frac{1}{2}a$, and where c, side of the angle block, is usually quite small compared with either a or b. These necessary restrictions, which do not appear to have been considered by our correspondents, make the practical solution very easy as compared with that of the general problem of the two rectangles.

There is, however, no mathematical difficulty in solving the general problem, and it is, in fact, much easier to derive an equation for the length x than many of our correspondents have imagined. Thus, let z be the angle between the lines a and x; then the angle between the lines b and c is also z, and we have the equations,

$$a = x\cos z + c\sin z$$
$$b = x\sin z + c\cos z$$

which contain the two unknown quantities x and z. Eliminating z by simple algebraic work, there is found

$$x^4 - (a^2 + b^2 + 2c^2)\,x^2 + 4\,a\,b\,c\,x = (a^2 + b^2 - c^2)\,c^2$$

which is a biquadratic having four roots, whose values can be algebraically expressed or numerically computed for any given case, by the well known methods stated in the text-book. Such is the solution of the general problem, simple, complete, and final, deduced without reference to ellipses, hyperbolas, conchoids, or other paraphernalia, whereby often discussions are complicated.

The numerical solution of a biquadratic equation involves, however, a great amount of tedious work, for it depends upon the solution of a cubic, and this in its turn upon that of a quadratic. The Howe truss angle block problem is indeed rarely practically solved in this way, but by short-cut approximate methods. Bearing this in mind, and also the fact that c is small compared with b, and that b is greater than $\frac{1}{2}a$, it appears perfectly possible to state a practically correct formula for the value of x, which shall be easy of application. Our consulting mathematician furnishes the following formula as a satisfactory solution:

$$x^2 = a^2 + b^2 + c^2 - \frac{4\,a\,b\,c}{\sqrt{a^2 + b^2}}$$

and he states that this has the great merit that it becomes exactly correct either when $c = 0$, or when $a = b$, and that it approaches perfect correctness the nearer these conditions are fulfilled. For instance, let $a = 20$ ft., $b = 12$ ft., and $c = 10$ ins. Then the solution of the biquadratic gives $x = 22.60$ ft., but by our practical formula scarcely one-tenth as much time and labor is required to find the value $x = 22.59$ ft.

Those who like to enjoy the pleasure of discussing the kind and position of the four roots for all possible values of a, b, and c must, of course, confine themselves to the biquadratic equation. But those who wish merely the numerical value of x, for the case of a Howe truss panel, can scarcely do better than to compute it from our practical formula—and then check it by a large scale drawing. For any common dimensions the result will not vary more than 0.01 ft. from the true root, and if a closer value is desired, simple substitution in the biquadratic will, after one or two trials, furnish the root more accurately than a steel tape can measure it.

The problem of practice is further complicated by the fact that the actual Howe truss panel is not a perfect rectangle, but a trapezoid, being made such in order to give a proper camber to the bridge. The only proper method for determining the length of the actual Howe truss brace, therefore, is some practical rule like that given in our last issue on the Canadian Pacific Railway; and with this statement we close the discussion of this old problem in these columns, for at least a year.

CORRESPONDENCE.

The Prismoidal Formula for Earthwork Computations.

SCRANTON, PA., Nov. 30, 1889.

TO THE EDITOR OF ENGINEERING NEWS:

You will certainly pardon me for feeling amused at the neat way in which you retort upon yourself the somewhat uncalled-for remarks that you make in your issue of November 30, regarding a few comments on the prismoidal formula extracted from my letter to you of the 11th inst. I refer, of course, to the obvious error you make in attempting to correct (under the mistaken notion that it needed correction) my calculation of the volume of a suppositious solid with end areas equal to zero, a mid-section of 1 sq. ft. and a length of 6 ft., by the prismoidal formula.

Let me also add here that I think you pervert the plain intention I had in giving the example in question, which was simply to show, by an extreme case, that the prismoidal formula only holds when the mid-area "lines up" with the end areas. But enough of this. I am interested in what you say regarding the circumstances under which averaging end-areas may give too small a volume. I am not sure, however, that I fully understand all that you assert in regard to this subject. You say "another (case) is a right-angled triangular pyramid, in which one end section is a vertical line and the other a horizontal line." I do not, I confess, form a distinct mental picture of this solid. Further on you say: "For instance, if two end sections differ 10 ft. in center height, the simple interposition of another section will add about 50 cu. yds. to the end-area volume," etc. Here again, I do not grasp the conditions, as the data seem incomplete.

One case which you cite, where averaging end-areas gives too small a volume, that namely "when the deepest centre height happens to be at one end of a solid, and the greatest width at the other end," seems to hold good, as can be shown, I think, by splitting the solid longitudinally through the centre heights, when the proof given by Prof. GILLESPIE in the later edition of his "Roads and Railroads" will apply to the two separate parts, and consequently to the whole. This fact I was not aware of when I wrote you my letter. I presume it may not be generally known; I find it given by Prof. GILLESPIE, who alone, I think, among the authorities I have hastily consulted since, fully shows the application of the prismoidal formula to this class of solids. I do not think this case would be a rare one in practice, and in any event it strengthens the argument in favor of averaging end-areas, in that it shows there is a chance to "even up" errors.

I join you in your admiration of what you truly call "that remarkable formula," namely, the prismoidal, only I think that, practically, there are some cases to which it applies better than to others. By the way, as still another case to which it applies—at first sight a little strange, but on reflection sufficiently obvious—may be mentioned that of the two pyramids already spoken of, if they be juxtaposed at the apexes, instead of the bases, and considered as forming one solid.

For the rest, your admission that "our correspondent's understanding of the limits of the prismoidal formula is perfectly correct in a practical sense" is all I can ask of you, for it is in this sense that I wish to regard the subject. S.

[Such satisfaction as our correspondent derives from the numerical error, an example to which he refers in the first part of his letter, he is entitled to.

His example showing that the prismoidal formula does not apply correctly to two triangular pyramids, placed base to base and then treated as one solid, does not show anything, for the reason that neither the prismoidal nor any other formula is expected to apply to irregular agglomerations of solids treated as one. How we could "pervert a plain intention" in pointing out that fact, we are unable to see. The intention spoke for itself. It was the manner of carrying it out that we objected to as unsound.

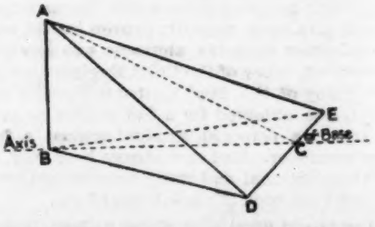
If our correspondent cannot conceive of a "right-angle triangular pyramid of which one end section is a vertical line and the other a horizontal line," we must refer him to any good treatise on solid geometry; but by a little effort we think he will be able to picture the solid, it having a triangular base, and three triangles as sides.

The instance advanced of two end sections differing 10 ft. in center height, the conditions of which our correspondent does not grasp, "as the data seem incomplete," is as complete as is necessary except that the usual side slope of 1½ to 1, which was assumed, might have been specifically mentioned. Otherwise the difference of center height is the only element seriously affecting the degree of error in the end-area method. Whether the end center heights be 0 and 10 ft., or 100 and 110 ft., the prismoidal correction will be 92.6 cu. yds. if the section be level; whereas, if an intermediate section be interposed in the original cross-section, the error on each of the two solids thus formed will be about one-eighth of that on the original, or 23.15 cu. yds. if the section be level, leaving 69.45 cu. yds. as the difference in end-area volume resulting from the simple interposition of another section. Under certain conditions of surface, this error might be only some 50 yds., and we put it at that to be on the safe side.

How the fact that the prismoidal formula applies to warped-surface solids also can "strengthen the argument in favor of averaging end-areas" it is difficult to see. We think our correspondent unsound both in his conclusion and reason therefor: but we repeat from last week that, while it is never good practice to compute rough earthwork wholly by end-areas, it is equally bad practice to compute originally by the prismoidal formula, and still worse, to reduce sections to "equivalent" level sections as a means for doing so conveniently. This always results in giving the volume too small of every solid which is not a perfect plane. The true rule is: Compute originally by end-areas. Have a little table of prismoidal corrections for given differences of center heights. For the purpose of determining a prismoidal correction, assume the sections to be level ones of their actual center height, and do not reduce to "equivalent" level sections. At any time during the process of construction, subtract the center heights from each other, and when they differ 2 ft. or more, determine a prismoidal correction for the solid from the little table referred to, add these corrections together for a given cut or section, and subtract them in gross from the end-area solidity. To this mode of using the prismoidal formula no rational objection can be advanced.—ED. ENG. NEWS.]

Our correspondent also sends us the following addendum:

Since writing the above, I perceive that the "mental picture" of your right-angled triangular pyramids can be easily and distinctly formed. Only I think you are wrong in saying that its calculation by averaging end areas would lead to too small a volume. I think it would lead to a volume 50 per cent. too great, for the area of the right-angle triangle would be one area, and zero the other, and the height, the altitude of the pyramid. Of course, in such a case, that is that of a pyramid or cone, the volume would not be calculated by averaging areas, nor by the prismoidal formula, but by the special rule, made and provided,



[It is evident that our correspondent has not yet conceived the form of the solid described, and we must maintain, clearly described, but as it is rather a curious one we add the above cut to make it perfectly clear. The solid is the "right-angled triangular pyramid" *A B D E* "in which one end section is a vertical line" (*A B*) "and the other a horizontal line" (*D E*) "and the end-area solidity of which is consequently zero." The triangles *A B D*, *A B C*, *A B E*, are all right angled.—ED. ENG. NEWS.]

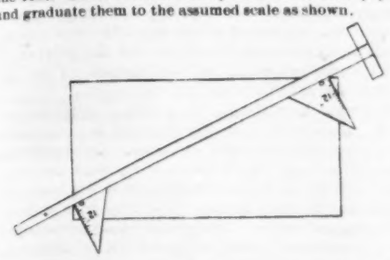
Practical Determination of the Length of Struts in Howe Trusses.

Bridge Department, Pencoyd Iron Works,
Nov. 18, 1889.

TO THE EDITOR OF ENGINEERING NEWS:

I send a graphical solution of the above, which we used entirely on the Rocky Mountain Division of the Canadian Pacific Railway a few years ago.

The diagram explains itself. Draw the outlines of the panel to a sufficiently large scale, say one inch to the foot. Cut two small set squares out of stiff paper and graduate them to the assumed scale as shown.



Now suppose the side of the diagonal—the length of which is required—to be 12 ins, then place the tee-square and two set squares in such a position that the zero mark and the 12-in. mark of each set square will coincide with the four sides of the panel respectively, which at once gives the length of the longest diagonal (in the case of 12 ins. width) which can be placed in the given panel, and also the dimensions of the angle block required.

The whole operation only takes a few minutes and is much quicker and more reliable than the analytical methods. It always checks itself, for to be accurate both angle blocks must be exactly the same.

Yours respectfully. T. KENNARD THOMSON.

The St. John's Dry-Dock.

ELMIRA, N. Y., Nov. 23, 1889.

TO THE EDITOR OF ENGINEERING NEWS:—

In the discussion on the Timber Dry Dock at St. Johns, as reprinted in your issue of Oct. 12th, I am made to say, "There can be little doubt that such material may, by suitable appliances, be most economically excavated 'by the day.'"

What I wrote in the original was, "in the dry." My plan would have been to close the coffer-dam as soon as possible, pump out the water, and then with pick and shovel excavate the material. To remove it, I would have used portable tracks in the bottom, and suitable dump boxes and platform cars.

The boxes to be hoisted out by suitably arranged derricks, and not emptied until they reached the dump. The delays from constant breakages of the excavating machines in the hard material were very numerous and costly, aside from the double handling of material which would have been avoided.

Yours truly,
F. COLLINGWOOD.

[The original printed copy is at present inaccessible, so we cannot say which proof-reader is at fault. But we print Mr. COLLINGWOOD'S correction as making an important difference.—ED. ENG. NEWS.]

Engineering Advertisements.

BRIDGETON, N. J. Dec. 4, 1889.

TO THE EDITOR OF ENGINEERING NEWS:—

Referring to the communication by Mr. T. COMERFORD MARTIN, in your issue of Nov. 23, I will say that I am glad to have so able and courteous an adversary, if adversary he be. It is highly probably, however, that a further discussion of the matter in question would show that we stand very nearly upon the same ground.

In writing my article upon "Engineering Advertisements," I certainly did not intend to particularly attack the American Institute of Electrical Engineers, as my remark would apply to the societies in Europe as well as here. I naturally stated a rather extreme view of the case, because I thought it was one that needed as free a discussion as possible.

I am well aware, as was stated in my article, that it is frequently for the interests of science that patented articles should be publicly described and discussed; and the exception to my general position was there made in favor of all *important* patents. It follows, as there are in this, the electrical age of the world, more wonderful and important electrical inventions than perhaps those of almost any other kind, that more patented ones in this particular field should properly go before the societies. The strongest ground I took against such was that they should run the gauntlet of very careful publication committees.

If the more or less gentle hints given in my article, and the discussion which has followed, shall be the means of keeping out from the society discussions even a few of the things objected to, which will sometimes creep in, my object will have been accomplished.

OBERLIN SMITH.

Slip Switch Cross-Overs.

PHILADELPHIA, Nov. 29, 1889.

TO THE EDITOR OF ENGINEERING NEWS:

Your issue of Nov. 16, page 463, illustrates a slip switch cross-over. It is an old device—see date on Sheet 1, diagram enclosed. We have found it to be objectionable when used for flat angles with the stiff frogs as shown on page 463, in consequence of the long, unprotected space between the points of the frogs. We are making numbers of them with movable points—see Sheet 2—inserted at *AA*, with every variety of stand and attachment to interlocking plants.

Very truly yours,
S. W. WILSON.

[For engravings accompanying this letter see page 557.—ED. ENG. NEWS.]

Aluminum Tests.

PITTSBURG, Pa., Dec. 9, 1889.

TO THE EDITOR OF ENGINEERING NEWS:—

We note the series of tests of aluminum alloys which you have published from Major TETMAJER, of the Polytechnic School of Zurich. Among them, we note that the tensile strength of the 5½ per cent. aluminum bronze was 62,581 lbs. per square inch, with an elongation of 64 per cent. This is considerably in excess of the results which we have been getting, although we do find a very great ductility with the same tensile strength as ordinary structural steel with this class of bronze. We find, however, that the stretch with aluminum and aluminum bronze is not a uniform stretch, but is a local stretch near the breaking point.

We send you a sample of pure aluminum wire, which gave 24,570 lbs. ultimate strength, 12,170 lbs. per square inch elastic limit, with 65.57 per cent. reduction of area; but you will note with reference to this specimen that the reduction is very local in its work. We should very much like to know the length in which the percentage of elongation was calculated in the table which you quote, and would very much like to have the name of the paper from which you made the quotations as to the tests of aluminum alloy; or, what would be better whether the address of Prof. TETMAJER, Polytechnic School of Zurich, Switzerland, is accurate.

We also note that you have printed our letter offering to give aluminum for tests with reference to surveying instruments, for which we are very much obliged to you.

We are pleased to report to you that our business is increasing very largely; and as a news item, you may state that we are now placing contracts to enlarge our plant over three-fold.

Very respectfully,
THE PITTSBURG REDUCTION CO.
ALFRED E. HUNT, *President.*

[The item quoted was in part taken from an exchange, without indication as to the original translator, from the German of Prof. TETMAJER. We note, in the sample enclosed, that the reduction in section is very local, as Mr. HUNT states. The total reduction is confined to an axial length barely equalling the diameter of the rod, as measured from the point of rupture. In the item referred to in our last issue there is an obvious transposition of adjectives in the statement made regarding the strength of brass wire. The hard, or unannealed wire is of course the strongest.—ED. ENG. NEWS.]

Advertising in Engineering Societies.

ORPINGTON, KENT., Nov. 29, 1889.

TO THE EDITOR OF ENGINEERING NEWS:

As engineers are invited to discuss the question of what papers should be read before Engineering Societies, I write to say that it appears to me that the question is capable of very simple solution by the committees in every individual case by putting it in this slightly different form (the reply to which is not difficult and which indicates unmistakably the right answer to the original question). "Do we accept this paper for its originality and engineering interests, or for the commercial benefit of an individual?"

I am afraid there can be no doubt that some committees frequently do deliberately select papers for the latter reason, even to the exclusion of papers of greater originality and engineering interest.

The only obvious remedy is for the Society to elect their governing body with a view to their regard rather for engineering than for dollars. I never could see that the fact of patent or no patent affected the question. Until private property ceases to exist by the introduction of universal socialism, there is no kind of property to which a man has so good a right as the product of his own thought and labor.

If he applies this labor to invention, he is, however, compelled by law to pay a heavy special tax before he is allowed to possess any of this property, and even then he surrenders by far the greater part of it to the public—losing all his rights after fourteen years—however valuable his work, and though he must spend several years in developing his invention. The most petty writing is protected for thirty years, and all "material" property is protected in perpetuity.

This inequality is simply because the inventors are still too small a minority to have justice done them, and the lawyers are still mediæval in their notions. The implied reproach that an engineer has made private property of his work seems therefore to me most out of place and even absurd. He has not done so any more than every man, commercial or professional, who endeavors to get pay for his labor. Indeed the very name "patent" signifies that he has disclosed and published and made fully known for the general benefit all the results of his labors.

I hope that engineers in the United States will not, under a mistaken idea of professional etiquette, allow a distinction between original work which is patented and that which is not. The question as it regards the reputation of the engineer is, "Is the work original and useful?" or, "Is it an important step of engineering progress?"

The engineer who does work which is not patentable must be paid on the spot. The patentee engineer, less fortunate, has to take deferred pay.

If there is any distinction, it should be in favor of the latter, as he concerns himself with solving problems in a way applicable in a variety of cases, while the former has only to consider the circumstances of an individual case, obviously so far an easier problem, and less useful.

But in point of fact, there is very little original work in most of what is specially called civil engineering in modern days. A railway is a copy of other railways, and a canal of other canals. When there was original work in such matters, they were also subjects of patents and quite rightly; and even now every improvement in them is patented. It therefore becomes evident that one reason why civil engineers are not oftener patentees is that there is not often originality in their work. When there is, they become patentees. Yours faithfully,

H. D. PEARSALL.
Assoc. M. Inst. C. E., M. Am. Inst. M. E.

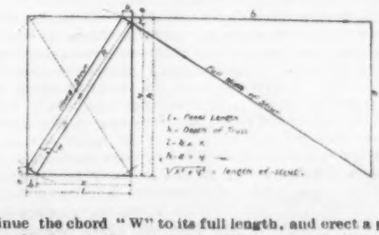
The Howe Truss Problem.

PHŒNIXVILLE, Pa., Nov. 26, 1889.

TO THE EDITOR OF ENGINEERING NEWS:—

A practical solution for obtaining length of the Howe strut is given as follows:

Draw diagram of panel to exact scale, and from the center, which is obtained by the intersection of the diagonals, describe with a trial radius "R" until areas are obtained whose chords are equal to the width "W." Con-



tinue the chord "W" to its full length, and erect a perpendicular at the extreme length to meet the line "*b*," which is an extension of the line representing the panel length of the top chord; *a* and *b* may now be measured from this full-size diagram; then proceed as shown in sketch.

Yours respectfully,
A. J. LESCHORS.

The Sewerage of San Diego.

NEWPORT, R. I., Nov. 26, 1889.

TO THE EDITOR OF ENGINEERING NEWS:

I have recently returned from Europe, and have only now seen your issue of October 5, with its articles on the "Sewerage of San Diego."

I was engaged to make the plans and specifications for this work, and, by a specific contract with the City Council, was given absolute control of its execution in every respect. Later, it was found that under the "Vrooman Act" all engineering must be done by the city engineer and all work under the control of the street commissioner. My organization was broken up, and I remained thereafter only an outside adviser, with only such influence over the work as I could exert personally, and with no absolute authority. So far, therefore, as the defects complained of are the result of bad workmanship, I am not responsible for them.

No sewer in the city could possibly run half full at the present time if it were free from obstruction due generally to improper laying. No flush tank could fail to work properly if it had been properly constructed. The imperfect setting is chargeable solely to the failure of the Street Commissioners' Department to secure good work from the contractor. That "out of 11,743 house connections provided for, only 813 are actually used" is due to the fact that the streets sewered are, as a rule, very scantily built upon and that the city authorities have not enforced their ordinance requiring householders to connect. It is stated that the Fourth St. sewer with 73 connections frequently runs more than half full. This is, for nearly its whole length, a steep sewer. Near its lower end it has a fall of more than 1 in 100. The last block of its length, in order to connect with the shallow main sewer, had to be laid at a grade of 1 to 300. Along this stretch it has a capacity of 23,13 cu. ft. per minute. With a water supply of 60 galls. per head for use in the houses, which is not likely ever to be reached in San Diego, a population of seven persons per house in 73 houses would cause, during the hour of greatest flow, a discharge of 4.25 cu. ft. per minute, being less than one-fifth the capacity of the sewer. The Commissioners' Report indicates either bad workmanship or accidental obstruction in either this branch or its main. It is not, however, very material whether this short piece of sewer, with a steep sewer immediately behind it, runs full or not. It could be made to work under a head of severa. feet during the hour of greatest flow, without injury or inconvenience; this, however, will never happen if the sewer is free. The Commissioners find that only three stoppages have occurred in the sewers, which have been in use about a year and a half. The "numerous stoppages" in the house laterals are chargeable to the local mechanics by whom they have been laid. I had nothing whatever to do with them.

Concerning the harbor reservoir, which is so savagely condemned by the Commissioners, I am still of the opinion — and I think its correctness is demonstrable — that under the circumstances it was properly placed, that it is properly connected with the deep channel, that its automatic mechanism is satisfactory, and that, under friendly control and with some simple modifications, its working would have given no cause for complaint. It is stated that its bottom was filled to a level of mean low tide "with earth, gravel, clay, hard-pan, or broken sandstone, in large masses; everything, in fact, available in ordinary street grading in San Diego, dumped loosely from the deck of the scow used for its distribution, in piles here and there, without any attempt at packing, spreading, or leveling up to an even slope in any direction. Irregularities of two feet or more in level appear, with occasional holes of greater depth."

My specifications and the contract based on them called for the filling of the bottom with harbor sand or other earth to one foot below low tide, and for clay, loam, or hard-pan and gravel, one foot deep over the above foundation and leveled to an elevation 8½ feet below the level of the city datum" [low tide]. That this requirement was permitted to be evaded is due solely to the manner in which the work was controlled.

I am, however, free to confess that if the bottom had been made as and where I prescribed, the result would still have been bad. There were two serious errors of omissions, due to inexperience and want of precedent in such work. The first was to fill the reservoir nearly to the height of low tide. Had there always been at low tide, say two feet of water, the movement of this water during the filling and emptying of the reservoir would have led to the removal of a very large proportion of what is now deposited; though probably there would still have been slight objectionable deposits in those parts of the reservoir where the movement was sluggish, objectionable, but not nearly so bad as when exposed to the sun and air. The second was not to have foreseen the importance of a training channel for the outflow. I recommended long since an inexpensive modification which would have overcome this difficulty. It was not carried out, the present managers of the work having ideas of their own on the subject.

My former assistant, Mr. SPECHT, never reported on the present outlet. My first instruction had been to make a temporary outlet at the end of the H street wharf. I sent him to investigate the subject, and he very properly reported this to be "highly objectionable." He recommended a point for the location of a reservoir like the present one a couple of miles farther away. My own preference was for irrigation disposal at about the point indicated by the present commissioners. Mr. SPECHT'S position was not available, because the line leading to it would cut off navigation to Old Town and the irrigation project was objected to, not only because of the great cost of getting the sewage to that point, but because at that time all land within miles of San Diego had a great speculative value. An outlet to the Pacific near False Bay was also studied and found too costly. The location of the present reservoir and outlet was the result of much consultation, and was accepted on all hands as the best. With more money available, I should not have recommended placing it so near the city. Now that it is there, it can be made unobjectionable if properly treated.

Experience thus far had satisfies me that nothing more is necessary to the success of the present outlet than a possible and proper regulation of the reservoir. There is no reason for, nor is there reason in, the proposed temporary expedient, which will pour sewage into the harbor on the outgoing and on the incoming tide, during most of the time. The sewage discharged will generally be sufficient to overcome the rising tide, and maintain constant outward flow.

It is sometimes interesting to seek the motive of a criticism. Neither professional jealousy; nor, among local engineers, jealousy of non-resident experts; nor, among Californians, jealousy of Eastern men; can of course be regarded a factor in this case. Perhaps we need look no farther than to the fact that the city of San Diego still owes me a large sum of money on its written contract with me, and that, in its present financial condition, the most popular thing that a politician can do is to fling mud at the city's creditors. I think it will be found, after it shall have regained its prosperity and shall have paid its debts, that the intelligent portion of its population has not been without justification, in all these months, in thinking they have a very good and very satisfactory system of sewerage. It behooves them, however, to prevent ignorant tampering with the main outlet.

Very respectfully,

GEORGE E. WARING.

Notes and Queries.

I. D. asks: "Some time ago, you published a long article with plates descriptive of the Eddystone Lighthouse Construction. If I am correct, can you please send me two copies? I think it was in the early part of 1888."

It was published in our issues of April 10 and 19, 1884, and the numbers are now out of print. Our correspondent would be wiser to preserve his files.

A. C. M. asks: "I desire to become a member of the American Society of Civil Engineers, and take the liberty of applying to you for information of the subject, as I do not know the name or address of the Secretary. I wish to know, first, the proper method for applying for membership, and secondly the probable yearly cost of same."

A letter addressed to JOHN BOGART, Secretary Am'. Soc. C. E., 127 E. 23d St., New York, will bring all the necessary information and blanks. The entrance fee is now $30, and the annual dues $15 for non-resident members; $25 for residents, that is, those living within fifty miles of New York.

Mr. L. Y. SCHERMERHORN, 1428 Arch St., Philadelphia, asks: Can you or any readers of ENGINEERING NEWS refer me to printed reports or papers relating to the use of concrete in recent breakwater construction in Europe.

Our impression is that there have been several papers before the Inst. C. E., and Continental Engineering Societies relating to this subject, which examination of files would show, but doubtless some of our readers can give more specific references.

Methods of Reducing the Fire Loss.

At a recent meeting of the American Society of Mechanical Engineers a valuable paper, with the above title, was presented by Mr. C. J. H. WOODBURY. At the present time, when public attention has been so strongly turned in this direction, data on the subject from an acknowledged expert are especially pertinent. We abstract the paper as fully as our space will permit.

In presenting his paper, Mr. WOODBURY expressed his belief that there are very few fires which might not have been prevented by proper and feasible precautions. Many fires, however, are caused by the burning of adjacent buildings, not controlled by the injured party. It is not proposed in this paper to consider this class of risks so much as the protection of isolated manufacturing property.

SUPERVISION.

Care is the most important element in the preventing and extinguishment of fires, as is shown by statistics of the causes of mill fires extending back many years.

In a manufactory there is a wide distinction to be made between to-day's dirt and yesterday's dirt. Nearly every kind of bye-product is liable to spontaneous ignition, and should be removed to a place of safety before night. This precaution does not apply merely to oily waste, but to every kind of waste material, even including iron turnings, whose oxidation when wet is a frequent cause of fire. It is not safe to make a discrimination in regard to oily waste, because there are numerous fires started in what is considered, and truly appears to be, clean waste. The best waste boxes are made of galvanized iron, like small ash cans, except that they are provided with short legs, so as to stand about four inches above the floor. The waste cans, after being emptied at night, can be overturned in the middle of the floor; any infraction of this rule to be reported by the watchman.

A plan now giving good results in actual use is as follows: Two foremen or overseers are appointed inspectors, and on Saturday afternoon a tour of the whole works, is made, and a report is given to the manager upon a sheet of paper ruled in squares, each of the horizontal lines referring to a single room, and the vertical lines dividing it into columns for marking the condition of the room, machinery, fire apparatus, lighting and heating apparatus, etc. Approval being marked by a circle, fault by a cross, and the absence of the feature in the column by a dash, the completeness of the report is assured by a mark in every square.

The watchman should be a strong and efficient man. Remember that the property is in his sole care about five-eighths of the time. He should go through and not merely across every room, and step out doors at least once an hour, that his sense of smell may be more acute to detect the odor of spontaneous combustion. The patrol should be recorded on a watchman's clock to prove his faithfulness. The mechanical clocks are being supplanted by the electric, of which the preferable type is the one in which the electricity is generated by a magneto machine, and the necessity of batteries is obviated. Of course, connection with telephone and city fire alarm circuits is indispensable where it can be had.

Automatic fire alarms, by which an electrical circuit is closed, have been devised in great number, but have shown a general tendency to get out of order, and a liability to give false alarms. The relief from the hazard in lighting up a mill, which is necessarily done by the help employed, has made electric lighting the safest method of illumination.

Lack of proper lubrication, especially on main bearings, is a fruitful source of fire. Careful attention should be paid to keeping the bearings in line, and securing their regular oiling. Oil should be stored in a separate building, either below the surface or banked around. Stringent measures should be adopted to prevent drawing oil by artificial light.

Steam pipes should be free from contact with combustible material, and care should be taken that they are not covered with a non-conducting material, which will ignite at the temperature to which they are exposed. The overhead system of piping—placing the coils about 3 ft. from the walls and 2 ft. below the ceiling—is much safer than the old method of placing the pipes next the walls and near the floor, as well as more economical; but the still later method of warming a building by blowing air which has been heated by passing through a case containing the coil of steam pipes is now considered the most desirable and efficient means of heating a building, and is also commendable on account of its freedom from fire hazard.

Fire apparatus should be kept in service as well as in order; and the fire organization should drill at least twice a month. By way of a distinctive feature, the members of one fire organization are provided with belts with a special clasp, and when any person wearing one of these belts leaves work, he is to give up his belt to his alternate before leaving the yard. In this manner, by retaining the wearers of the belts always on the premises, it is arranged that there shall always be a fully manned fire organization present during the working hours of the week.

The results of the work of these trained fire organizations has been most gratifying. Systematic and skilful work has been the rule in place of the panic, confusion, and breakage of apparatus where no organization exists.

Pumps should not be kept for fire purposes only, but should be put in operation at least once a week. Gates in water mains should be marked with an arrow showing the direction of opening. The drip valve for draining the system of pipes should be convenient of access. Valves to automatic sprinklers should be sealed open by a strap around the pipe and one of the spokes of the valve wheel, secured by a rivet or belt cement.

A fruitful source of disarranged fire apparatus is freezing in the winter months. The hazard in a hydrant or other part of the plant broken by frost is not so much from the disuse of that particular part of the plant, but in the danger that the whole

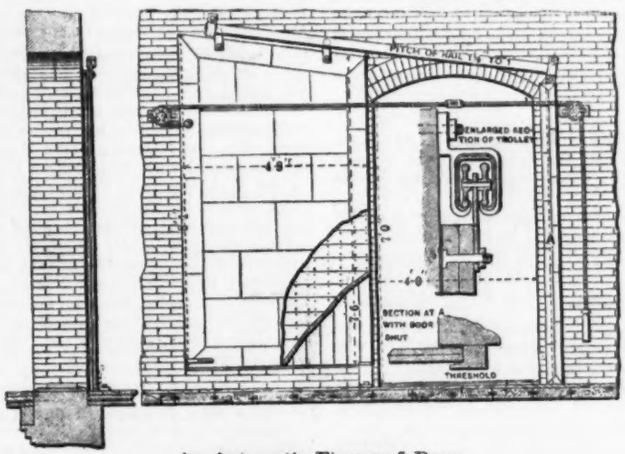
apparatus may be rendered useless by the one failure.

CONSTRUCTION.

An absolutely fireproof mill would be commercially impracticable, both by reason of cost and of hindrances to manufacturing necessarily involved in the construction. Iron and masonry construction, as formerly adopted for mills and called fireproof, has not resulted in lessening the fire loss in proportion to its increased cost.

The method of mill building known as slow-burning construction combines the advantage of low initial cost and great resistance to destruction by fire, the final result being that the manufacturing process is housed at the minimum annual cost. Such slow-burning methods of construction also furnish the most advantageous arrangements for manufacture as to stability, light, and application of power.

The fundamental principle of slow-burning construction is to mass the material in such a way that there shall not be any concealed spaces about the structure, and



An Automatic Fireproof Door.

that the number of projections of timber, which are more easily ignited than the flat surfaces, shall be reduced as far as possible; that iron portions of the structure shall not be exposed to the heat of any fire in the contents of the building, and furthermore that the isolation of the various portions shall be as complete as is feasible—both as respects one building from another and the various rooms and stories of the same building from each other.

The most important feature in slow-burning construction is the mill floors. These should be laid on beams, generally of Southern pine, 12 x 14 ins., or 2 ins. larger when required by unusual loads or longer span than 22 ft. These beams are placed from 8 to 10 ft. apart between centres, and it is preferable that they should be made up of two pieces bolted side by side, with small blocks interposed to provide an air space of about an inch, as this will diminish the tendency to decay or to twist as the result of long-continued seasoning. At the anchorage of the walls the beams should rest upon cast-iron plates secured into the walls and provided with a rib on the top 1½ ins. in height projecting into a wide groove across the bottom of the beam and brought to a firm bearing by a pair of wedges driven into a groove each side of the iron tongue. It is important that an air space should be left in the wall each side and at the end of the beam to prevent dry rot, and that the bricks in the wall for about four rows immediately above the beam should be laid in dry sand. A preferable modification of this is to use a cast-iron box made to receive the end of the beam, and separated from contact on the top, end, and sides of the beam by ribs projecting on the inside of the box. As in the former case these iron supports are securely built in the wall. This arrangement is much more stable in anchoring the beams to the wall, and if by reason of fire the beams break, they will slide out from their anchorage without injury to the wall as soon as the groove on the bottom of the beam clears the rib in the supporting plate.

At the columns, beams rest on cast-iron caps which should present a supporting area at least three times that of the cross-section of the wood columns used, as the resistance of timber to longitudinal crushing is three times that of its resistance across the grain. The support from one column to the next should be made by cast-iron pintles, preferably those whose section is in the form of a Greek cross, as that presents advantages in the way of securely joining them to the wood columns. At the top of the pintle, a cast-iron plate should support the base of the column above. A flat plate with a projection in the middle securing the column by insertion into the core of the column is preferable to the cup form which is so frequently used, as the latter tends to retain moisture to the deterioration of the column by dry rot.

Timber columns are preferred to those of iron, unless the load is greater than can be sustained by timber,—the limitation of a load on oak or Southern pine of straight grain and free from knots being about 600 lbs. per sq. in. Such columns, when subjected to destructive tests, give way by direct crushing, and for this reason the tendency of late years has been to make square instead of round columns. These offer no greater obstruction on the floor than the round columns and give about one-fourth extra resistance. Whenever the amount of load renders it necessary to use iron columns, they should be protected by wire lath and plaster, or by some of the special tiles made for the purpose.

The floor planks for this type of floor are generally made of spruce plank from three to four inches in thickness, grooved on both edges, and joined together by hardwood splines. These floor planks should be two bays in length, breaking joints at least every 3 ft.

Above this the top floor, of 1¼ to 1½ in. hard wood, is laid; and in some instances the resistance of the floor to fire is greatly increased by laying a coat of plaster on the floor plank before the top flooring is put on. But the general method of increasing the resistance of the floor to fire is to cover the floor and beams on the under side with plaster laid on wire lathing. Whenever anything of this kind is done, care should be taken that the covering to the timber should not be hermetically sealed, as that course increases the tendency to dry rot, particularly if the timber is not very thoroughly seasoned at the time of its application. There have been a number of failures of the strength of such construction on account of the disregard of this well-known principle, that it is not desirable to seal up the outside of unseasoned timber. This not only applies to the method cited above, but also to paints and varnishes which are laid on such work before it is thoroughly seasoned.

In mill floors of very large area, care should be taken that the transverse shrinking of the floor should not pull the walls; and on large, low structures, which are far enough across to be affected by a very slight longitudinal shrinkage of the beams, other methods of anchorage than the one referred to should be adopted.

In its general construction the mill roof is similar to the mill floor, but it is somewhat lighter. The ends of the rafters serve as brackets for the roof planks and make a finish without the use of hollow cornices with gutters. With the roof three or four inches thick, there will be no trouble from condensation on the under side in cold weather. A coal-tar concrete walk about the building will protect the foundations and take care of water dripping from the roof.

In brick structures, pilasters are becoming more common, as they make a stronger and also a better looking wall. With buildings one or two stories in height, the walls are made of plank in a manner similar to the mill floor.

Such a construction offers great resistance to fire and also possesses great economy as regards the low cost of construction. As the floor is about 10 ins. thinner than joisted floors of equal strength, nearly one foot per story is saved in height of the wall, stairs, belting, steam and water pipes, etc., There is no record of such a mill floor, without belt or other holes in it, being burned through by a fire starting in the room below.

A mill floor should be designed, not with regard to its working strength; but with regard to the permissible deflection of the beams and plank when loaded.

The usual method of fixing upon the limit of such deflections as a constant ratio of the span is clearly wrong in principle, the form of the flexure being a curve, and therefore not a constant ratio of the span. The proper allowance, however, of the measure of the amount of distortion allowed to the floor is that of the mean radius of curvature, a safe limit being that the deflection in inches should not exceed .002 multiplied by the square of the span in feet.

Floors near the earth in basements should be well ventilated, if there is a space between the floor and the surface of the earth; but unless that space is continuous and 2 or 3 ft. in height, it is better to lay the floor directly upon the earth, taking care to prevent dampness by putting in a layer of stones or cinders. Above this the sills for the floor are laid in a trench with coal-tar concrete, which is also laid between the sills, on a level with the top of them, and the floor boards are laid over this. When well-seasoned chestnut is used for this purpose, it will last a great many years without dry rot. Cement concrete will cause timber to decay rapidly.

Windows for a mill should be placed as high as possible. The sills should be sloping, so that articles will not be left upon them in a disorderly manner. Ventilation is best arranged for by sashes swinging like a transom. Where direct currents of air affect the work, a portion of the middle sash, about 18 ins. square, may be deflected inward into the room. The top of the bracket-like projection thus formed has a cover which can be opened at will. Thus the incoming air is directed upward toward the ceiling and uniformly diffused. In wide one-story mills, where light at the center is necessary, the monitor roof gives best satisfaction.

Place stairways in masonry towers at one corner or just outside the mill, and provide substantial doors at each story. Make stairs in straight runs with square turns rather than winding. Elevators may be safely placed at almost any point where they are most needed, provided the openings at each floor are kept closed by automatic hatches.

Fire walls are frequently not so efficient as expected because of defective doors.

The best form of fire-door is that made of two thicknesses of matched boards, placed at right angles to each other and nailed together, being covered on the outside by tin, securely locked together and held to the door by numerous hanging strips. The door should be secured to the hangers by means of bolts, not screws, and the rail upon which it runs should be strongly bolted to the wall. When closed, such door should fit into a jamb, and be securely held in this manner against the wall. Such doors are frequently hung upon an inclined track, and, by some application of highly fusible solder at the catch, are so arranged that they will be closed by the heat of a fire, if not closed by hand. This same principle may be applied to fireproof shutters hung over various openings which necessarily exist in walls which are desired to form a fireproof separation between portions of a building. A fire-wall must extend through the roof, cutting off continuity of woodwork, especially at the roof cornices. The top of such a fire-wall can be covered with tiling, which is made in special form for such purposes, better than by a stone coping.

MACHINERY.

Few fires start in boiler-rooms. The risk there is understood and looked out for. Spontaneous ignition of bituminous coal is a frequent source of fire, especially when stored in a damp, warm place in large quantities. It should not be stored under valuable buildings, nor in contact with timber. When one lot is used, the shed should be swept before a new supply is put in. When the depth of the coal exceeds 8 ft., iron rods should be pushed to the bottom of the heap, and examined daily to detect any heating in the mass.

Crude petroleum has caused many accidents, principally on account of faulty methods of storage. In lighting the burners, the flame must be applied before the spray is turned on. "Reduced" oil is much safer than crude, but very difficult to pump in cold weather. In a steam-engine room the chief hazard is due to neglected oily waste. Water-wheels occasionally wear away the wooden step, changing the height of the turbine shaft, and causing the bevel glass to strike fire and ignite the grease.

FIRE APPARATUS.

Buckets of water are the most effectual. Fire pails should be different from other pails used about the premises. They should be kept full, and there is generally need of casks of water as well. Galvanized iron pails are better than wood; and

indurated fibre pails are especially satisfactory where a metallic pail becomes corroded. Pails should not be kept in drying rooms. The water evaporates, to the detriment of the drying process. In unheated buildings the water in fire pails may be kept from freezing in winter by adding chloride of magnesium.

Automatic sprinklers have proved a most efficient form of fire apparatus.

In mill fires the average loss for an experience of twelve years shows that in those fires where automatic sprinklers formed a part of the apparatus operating upon the fire, the average loss amounted to only one-nineteenth of the average of all other losses. If the difference between these two averages represents the amount saved by the operation of automatic sprinklers, then the total damage from the number of fires, in places in which automatic sprinklers are accredited as forming a portion of the apparatus, has been reduced $6,250,000 by this valuable device.

The practical use of this device dates from the invention of the sealed automatic sprinkler by HENRY S. PARMALEE, of New Haven, twelve years ago. About 200,000 sprinklers of this type have been installed; and though it has now been superseded by other forms, to this inventor belongs the distinction of being the pioneer in the work. The total number of automatic sprinklers now set is about 2,000,000.

In installations there should be at least one sprinkler to each 100 sq. ft. of floor. There should be two sources of water supply; and if one of these is furnished by an elevated tank, the minimum head from the bottom of the tank to the highest sprinkler should be 12 ft.

The inability to withstand a freezing temperature is a serious defect of automatic sprinklers, not yet remedied. The dry-pipe systems, in which the water is kept from the sprinkler pipes until fire occurs, are complicated and have been found defective in practice. The best practice is in late autumn to draw the water from the sprinkler pipes in rooms where the temperature may fall below freezing.

The discharge of automatic sprinklers, including the resistance of the pipe fitting, may be represented by $Q = 0.6\ v\ \overline{p}$, in which Q = discharge per minute in cubic feet, and p = pressure in lbs. per sq. in.

When automatic sprinklers were first introduced, there were many fears that leakage and excessive discharge on small fires would neutralize any gain; at present, however, there are several sprinklers on the market which impose little risk of leakage from water pressure. An underwriters' association has collected statistics showing that out of 514,071 automatic sprinklers in actual service for an average of five years, under an average water pressure of 69 lbs. per square inch, there had been only 58 instances of leakage from water pressure and 317 of leakage from other causes than fire. The average yearly damage per plant by leakage was only $2.56.

Stand-pipes should be placed in the stairway towers with hydrants at each story. Hose attached should be festooned on a row of pins or doubled on a reel. Fire pumps are generally too small. From 200 to 250 galls. per minute should be allowed for each fire stream. A ring nozzle is not as efficient as a smooth nozzle; the relative discharge is as 3 to 4. On stand-pipes ¾-in. nozzles are large enough; but for yard service 1-in. to 1⅛-in. should be the size of nozzle. Hose should be 2½-ins., the loss by friction in hose of this size being only one-third what it is with 2-in. Water mains should be designed for a limit of velocity of 10 ft. per second when carrying the maximum flow.

Yard hydrants should be within 50 ft. of the buildings and covered with a small house containing hose, nozzles, axes, bars, and spanners. The doors should be high enough to avoid ice, or the house may be raised on a slight mound.

RESULTS.

These methods of supervision, building, and equipment do not refor to any ideality, but to measures which have been widely carried into effect for the purpose of reducing the fire loss, the result of such action being to diminish the cost of insuring industrial property engaged in such normally hazardous processes as textile manufacture and other industries, down to a yearly cost of less than one-fifth of one per cent. This has been accomplished by the consideration of sources of danger and their abatement, and by a course which has been in line with sound engineering principles, and also practical methods of manufacture; and it has thus been proved that it is cheaper to prevent a fire than to sustain a loss.

The Financial Exhibit of the Paris Exposition of 1889.

The current issue of *Le Génie Civil* gives official figures for the receipts from various sources of the Exposition just closed in Paris. In return for tickets issued, the *Crédit Foncier de France* has turned into the treasury of the Exposition the total sum of 21,500,000 francs, or say $4,300,000. To this sum must be added the relatively small amounts received from concessions granted to restaurants, drinking saloons, and merchants of all kinds, and finally the sum to be obtained from the sale of materials of construction. Turning these amounts into American money, we have the following:

Receipts from tickets	$4,300,000
Concessions of all kinds	400,000
Estimated sale of materials	200,000
Subventions from France	3,000,000
" " city of Paris	1,400,000
Grand total of receipts	$9,900,000

It was originally estimated that the total expenses of the Exposition would amount to a total of $8,600,000. But it is thought now that this total will not exceed $8,300,000. The final balance sheet will thus stand as follows.

Total receipts	$9,900,000
" expenses	8,300,000
Profit	$1,600,000

This is the result as announced by M. ALPHAND, and he thinks that the final settlement is more likely to show an excess than a lowering of this result.

In contrast to these figures, the Exhibition of 1878 stood as follows in regard to its financial outcome:

Receipts	$5,733,040
Expenses	11,078,000
Excess of Expenses	$6,344,960

It is only proper to add, however, that in the above account the State subvention of $4,737,040 was not added to the receipts as in the case of 1889.

The Exposition of 1867 was comparatively much better in this respect than 1878, as the following figures show:

Receipts	$5,428,932
Expenses	4,596,764
Excess of Receipts	$832,168

In the present case the excess of receipts will be divided into two parts; that is, the part due to balance of guarantee capital, and that which represents actual profits. The first part will probably be turned into the national treasury by virtue of the law of July 6, 1886, which specifies that the State shall benefit by any balance remaining from a surplus of receipts over expenses in similar cases. As to the second part, it will most likely be divided between the State and the City of Paris in the proportions in which these bodies contributed towards the enterprise, a proportion shown in the exhibit first given above.

Spontaneous Combustion of Cotton.

The admirable way in which the Boston Manufacturers' Mutual Fire Insurance Co. warn their customers by special circulars of new sources of danger as they are discovered is illustrated by a recent circular No. 26, relating to danger of fire from cotton bales impregnated with cotton-seed oil. As the circular is of interest in itself also, we reproduce it as follows:

Since the introduction of cotton-seed oil and its transmission in casks and barrels from one part of the country to another, a new danger has arisen to cotton in transportation, as cotton fibres saturated with this oil are very liable to spontaneous combustion. It may be that the more frequent fires in large cotton warehouses of the South and in cotton ships can be accounted for in this way. Up to this time the Mutual Insurance Companies have been subjected to but one loss in a cotton storehouse which could be attributed to this cause. This season, however, an instance of saturated cotton bales has been discovered in one of our principal mills. Two bales have been received, one of which was saturated to the extent of 256 lbs.; the other to the extent of 175 lbs. They were fortunately discovered to be in this condition and a claim for damages has been made upon the Transportation Companies. A sample of the cotton has been examined at the Institute of Technology, and tested in our spontaneous combustion oven. It ignited at moderate heat in the way in which fibrous substances ignite when saturated with a drying or quickly oxidizing oil. The oil pressed out from this small sample has been subjected to qualitative tests, which prove it to be cotton-seed oil. We therefore warn all our members who represent cotton mills that it would be prudent to have their cotton carefully examined for oil, bale by bale, before putting it into the warehouse.

Snow-Shed Details, Minor Structures, Canadian Pacific Railway.

(With Inset.)

We continue our series of illustrations of the minor structures of the Canadian Pacific Railway, with the accompanying three drawings of snow-shed details. We have already (ENGINEERING NEWS, Jan. 21, 1888) given general drawings of these structures, of which those now given are in part a repetition, but the structures have proved so admirable for their purpose that another presentation of some of the main dimensions will be pardoned for the sake of the new and further details. Only where such structures are exposed to danger of avalanches can the massive work that has been used on some of the snow-sheds of the Canadian Pacific Railway be necessary; but a number of them are of lighter design, as will be seen, and all have stood the test of service remarkably well. On the Union and Northern Pacific Railways the snow-sheds are of very much lighter design, not being exposed either to avalanches or such heavy snow fall. In designing these sheds, therefore, the Canadian Pacific was working to some extent in the dark; but their success was so great that these designs are likely to remain the permanent type for snow-sheds exposed to heavy service.

Fig. 4 shows the portal details for timbered tunnels in earth, the portal itself being naturally of a temporary nature where the lining is. While the timber remains solid, however, it has proved satisfactory. We shall, in our next illustrations of this series, show the tunnel sections themselves for earth and rock.

The New Orleans Bridge Question.

The Commission of United States Engineers' appointed by the Secretary of War to consider and report upon the two Senate bills for a bridge below and a bridge above New Orleans, across the Mississippi River, was made up of Col. CYRUS COMSTOCK, Maj. CHARLES J. ALLEN, and Capt. DAN. C. KINGMAN, United States Engineer Corps. They commenced their labors on Nov. 29.

Mr. THOMAS C. CLARKE, consulting engineer for the New Orleans Terminal Railway & Bridge Co., submitted plans for a proposed single-track bridge below the city. It was to be 2,840 ft. long with two pivot spans, opening together, so as to give a clear opening of 224 ft. each, or 448 ft. in all. As giving some idea of the traffic passing the bridge site, he said that in the year ending June 30, 1889, 848 steamships came up with 1,696 passages, together with coasting steamers making 578 passages and sailing vessels 326 passages; a total of 2,600 passages at the bridge site. In addition to these, many small luggers pass daily. Rather than open the draw for these smaller vessels, he thought it would pay the bridge company to maintain a tug of its own. The pivot piers would be lighted by lamps 500 ft. apart, and steam whistles would indicate their position in case of dense fogs. The rest-piers at each end of the open draw-spans would be connected by lines of piling faced with timbers to prevent vessels from running into the spans.

This double-draw system of construction was perfectly feasible, said Mr. CLARKE, and when closed for trains they would be but the usual cantilever type of bridge. The shore piers to the draw-spans would be fitted as anchorages by steel rods running through them, and connecting with a steel girder on the pier; bolts moved by the central machinery would tie the shore ends down to these girders. The cantilevers would be cambered so as to come to a level under the heaviest trains. The piers would be sunk by dredging in open caissons, and the spans floated out on pontoons. The bridge could be built in 2½ years.

The representatives of railway and steamer lines gave considerable testimony for and against bridges generally. The Louisville & Nashville Railroad Co. favored the lower site; though the statement was made that for all railways except this road and

the Northeastern, a crossing nine or ten miles above the city would suit best. There are six trunk lines entering the city on the east bank, and only the Southern Pacific and the Texas & Pacific Railroads on the west bank. The amount of business transferred from one side of the river to the other is now about 100,000 cars annually, and the representative of the Illinois Central Railroad thought that a bridge would not be justified unless this traffic were much increased. The increased haul by the majority of the companies seemed to be at the bottom of their opposition to a lower bridge. There was also considerable effort made to find out in whose interest the lower bridge was to be constructed, and Mr. HUTCHINSON, of the Southern Pacific system, contended that unless it could be shown that this bridge was to be utilized by the railways, Congress should not authorize its construction at all.

Mr. HAARSTICK, president of the St. Louis & Mississippi Valley Transportation Co., said that any bridge built at New Orleans should have a clear headway of 75 ft. at high water, and a clear channel of 1,000 ft. between piers. He favored a bridge above the city, as one below will interfere much with ocean traffic and increase insurance rates. The marine underwriters and steamship agents also protested against the lower bridge.

The bridge site above the city was then taken up, by the reading of certain communications from Mr. E. L. CORTHELL, Consulting Engineer for the Southern Bridge & Railway Co., and now President of the Board of Directors. The dimensions of the proposed bridge, as given in the Senate bill, call for two channel spans not less than 800 ft. long in the clear at low water. The clear headway is to be 75 ft. at high-water mark. The location of the bridge would be about ten miles above the city, between Nine Mile and Twelve Mile Points. Plans for a draw and a pontoon bridge were discussed for the same site; but they were abandoned as impracticable in construction and operation, and decidedly dangerous to the navigation interests. The Memphis bridge now building will also have 75 ft. headway.

The river at this point is 2,600 ft. wide between low-water marks, and Mr. CORTHELL thought that the main channel spans, one on each side of the river, would exceed 800 ft. in length, and may even reach 900 ft. or 1,000 ft. He purposely framed the bill so as to limit him only in the minimum span. The cantilever principle was the only plan practicable. The maximum depth of water was 86 ft. at low water, and by a long span the deepest pier could be put in 73 ft. water and the other one in only 40 ft. The rough estimate of the cost of the structure is $3,000,000. If independent spans are to be used, they would be erected from pontoons; if continuous spans are built, the central span of 1,000 ft. would be erected on the cantilever principle. As the *Chicago*, our largest naval cruiser, stands 81 ft. above water, with her topmast lowered, this bridge is sufficient for the passage of the navy.

Mr. HUTCHINSON, in answer to a query concerning the cost of hauling cars over the lower bridge, was told that this question had not been considered, but that the bridge company expected to make it to the interest of railway companies to use the bridge. Mr. HUTCHINSON thought it would have been wiser in a company proposing to spend $2,000,000 on a bridge to first ascertain who was to use it and how much they would pay. The commission has returned to Washington.

A Manual of Railway Field Work and Laying Out of Works.

ACCORDING TO THE MOST RECENT AND APPROVED PRACTICE ON AMERICAN RAILWAYS.

BY A. M. WELLINGTON,
M.Am.Soc.C.E., M.Inst.C.E., etc.

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[The author will be pleased to receive typographical or other corrections, or suggestions as to form or substance, from any interested reader. All such suggestions will have full consideration.]

CHAPTER II. THEORETICAL PRELIMINARIES.

[*Continued from* p. 547.]

The following is a special application of this formula:

TO DETERMINE APPROXIMATELY THE MIDDLE ORDINATE OF SMALL ARCS.

[Any middle ordinate is given exactly by Eq. ( ) and Table 14.]

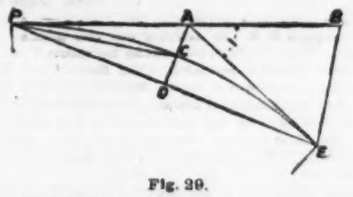

Fig. 29.

Let $P\,C\,E$, Fig. 29, be an arc n stations long of a $D°$ curve, for which it is desired to determine the middle ordinate, and $P\,B$ a tangent of length = $P\,E$. Draw the tangent $E\,A$, cutting $P\,B$ in A.

Then we have the distance $P\,C = \frac{n}{2}$ nearly, and the angle $C\,P\,D = \frac{1}{4}\,I = \frac{1}{4}\,n\,D$. But as the chord to an arc of 1° 1 station long = 1.74 +, Eq. ( ), we have for the value of $C\,D = M$:

$$M = \tfrac{1}{4}\,n\,D \times \frac{n}{2} \times 1.74$$

$$= \frac{1.74}{8}\,n^2\,D$$

or $$M = 0.22\,(0.218)\,n^2\,D$$

When $n = 1$, we have for the middle ordinate of any arc 1 *station long*:

$$M = 0.22\,(0.218\text{ exactly})\,D \qquad (\ )$$

This formula is practically exact for all ordinary arcs of 1 station. Thus the exact middle ordinate

For a 1° curve is	0.218;	by formula	0.218
" 5° "	1.091;	"	1.090
" 10° "	2.181;	"	2.180
" 20° "	4.362;	"	4.360

For the easier curves, it is practically exact for arcs of several stations. Thus the middle ordinate

For a 4° curve	2	stations long is	3.490;	by formula	3.488
" " "	3	" "	7.848;	"	7.843
" 2° "	4	" "	13.943;	"	13.932
" " "	6	" "	15.694;	"	15.686

By an extension of the formula, we have, by a demonstration similar to that of §——, *for the difference between the middle ordinates of any two curves of $D°$ and $D'°$*:

$$M_3 - M_4 = 0.22\,(0.218\text{ exactly})\,n^2\,(D - D'). \qquad (\ )$$

Example.—Difference between middle ordinates of an arc 3 stations long for a 3° and 5° curve: $0.218 \times 3^2 \times (5-3) = 3.924$ ft.; exactly 3.919 ft.

RAILS are usually 30 ft. long, with a certain percentage (about 5 per cent.) of shorter rails, 28 ft. or 26 ft. long, which latter are made necessary by the fact that after rolling, a certain percentage of rails otherwise good have more imperfections at the end than are admissible.

TO DETERMINE MIDDLE ORDINATES FOR BENDING RAILS, we have by Eq. ( )

$$M = 0.22\,(0.3)^2\,D$$

$$= 0.02\,D\ nearly = \frac{D}{50} \qquad (\ )$$

Similarly we have for 28-ft. rails:

$$M = 0.22\,(0.28)^2\,D$$

$$= 0.0171\,D = \frac{D}{60}\ nearly \qquad (\ )$$

and for 26 ft. rails

$$M = 0.22\,(0.26)^2\,D$$

$$= 0.0147 = \frac{D}{70}\ nearly \qquad (\ )$$

These formulas are practically exact for all curves under all conditions. It is not usual to bend rails with very great exactitude, for the reason that the final adjustment depends upon the surfacing of the track, and a slight spring in the rails is put in, and retained with great ease whether the rails be correctly curved or not. In fact, it is not uncommon to neglect to bend the rails at all for curves of less than 3° or 4°, depending entirely upon springing the rails in surfacing to perfect the line. But this practice is a vicious one, because, although the correct curvature is very easily sprung into any curve of less than 5° in surfacing, and the line may be so maintained for a considerable time, yet there is a constant tendency for the rails to spring back again into straight lines, with very bad effect upon the appearance and riding qualities of the curves.

Example.—10° curves; ordinate by bending 30-ft. rails, $\frac{10}{50} = 0.200$; should be 0.196. Ordinate for 28-ft. rails, $\frac{10}{60} = 0.167$; should be 0.171. Ordinate for 26-ft. rails, $\frac{10}{70} = 0.143$; should be 0.147.

These ordinates being so closely approximate, and so readily determined at any time, the usual table of ordinates for bending rails is omitted from this volume. The following is an abbreviated table:

Degree of curve.	Middle Ordinates in Feet for Rails of 30 ft.	28 ft.	26 ft.
1°	.0196	.0171	.0147
2°	.0392	.0342	.0294
3°	.0588	.0513	.0441
4°	.0784	.0684	.0588
5°	.0980	.0855	.0735
6°	.1176	.1026	.0882
7°	.1372	.1197	.1029
8°	.1568	.1368	.1176
9°	.1764	.1539	.1323
10°	.1960	.1710	.1470
11°	.2156	.1881	.1617
12°	.2352	.2052	.1764
13°	.2548	.2223	.1911
14°	.2744	.2394	.2058
15°	.2940	.2565	.2205
16°	.3136	.2736	.2352
17°	.3332	.2907	.2499
18°	.3528	.3078	.2646
19°	.3724	.3249	.2793
20°	.3920	.3420	.2940

GIVEN THE MIDDLE ORDINATE OF ANY CIRCULAR ARC, $P\,M\,T$, FIG. 29, TO DETERMINE ORDINATES AT THE QUARTER POINTS OF THE ARC, $F\,G$.

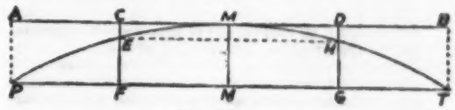

Fig. 30

Draw the line $A\,B$, Fig. 30, tangent to the arc at its center M. Then $A\,P = B\,T = MM$, and, by §. . . , from the similarity of circular and parabolic arcs, we have:

$$C\,E = \tfrac{1}{4}\,A\,P = \tfrac{1}{4}\,MM$$

letting $$MM = M:$$

$$E\,F = C\,F - C\,E$$

$$= M - \tfrac{1}{4}\,M$$

or $$E\,F = \tfrac{3}{4}\,M. \qquad (\ )$$

Similarly, TO DETERMINE ORDINATES FROM A CHORD TO ANY POINT OF A CIRCULAR ARC, in terms of the middle ordinate M:

Dividing the half chord $P\,M$ and parallel tangent into any desired number of parts = n, we have for the first offset a, at the point marked 1, Fig. 31 by Eq. ( ):

$$a = \frac{M}{n^2}$$

and for the successive ordinates from the curve

$$a, \quad 4a, \quad 9a, \quad 16a \ \ldots \ n^2\,a\,(= M) \qquad (\ )$$

whence the successive ordinates from the chord are

$$M,\ M\text{-}a,\ M\text{-}4a,\ M\text{-}9a, \text{ etc. to } \ldots \quad O \qquad (\ )$$

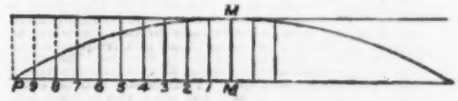

Fig. 31.

If we divide the half chord of any circular arc in 10 equal parts we have $a = \frac{M}{100}$, and for the successive offsets we have in terms of M:

	At M	1	2	3	4	5	6	7	8	9	At P
Offsets from tangent	0	.01	.04	.09	.16	.25	.36	.49	.64	.81	1.00
Offsets from chord	1.00	.99	.96	.91	.84	.75	.64	.51,	.36	.09,	0.00

In like manner offsets at any desired intervals, or at any desired point, may be obtained. For any point n ft. from M, Fig. 31, letting the half chord $P\,M = c$, the offset from tangent will be, by Eq. ( ):

$$O = \left(\frac{n}{c}\right)^2 M \qquad (\ )$$

This formula is exact to within .01 ft. up to middle ordinates of about 16 ft. for any arc. As a rule, however, ordinates from a chord for more than the middle and quarter points are not required.

Example.—On 3° curve, chord 240 ft. long, offset from tangent at a point 35 ft. from center of arc. We have $M = 0.218 \times 2.4^2 \times 3 = 3.77$ ft. (exact value, by Table 14, 3.77), and required offset

$$= \left(\frac{35}{120}\right)^2 \times 3.77 = .08507 \times 3.77 = 0.3207 \text{ (exact to last decimal).}$$

Mr. J. FOSTER FLAGG writes:—I trust that when you publish your proposed "Manual," you will not inflict upon us any more of the abominable 6-place tables of logarithms which seem to be traditionally handed down from one engineer's field-book to another, without any regard for their fitness for the purposes for which they are needed.

For all ordinary purposes a 5-place table (and for many, in fact, a 4-place one) is quite sufficiently accurate, and not only saves the labor involved in the use of the extra decimal, but also the labor of interpolation. If more accuracy is really necessary a 7-place table should be used. A 6-place table is neither "fish, flesh, nor good red herring."

The late Prof. BENJAMIN PIERCE of Harvard Univer

sity, in his preface to Bowditch's "Useful Tables," clearly expresses the objection to 6-place tables, as follows:

"It is a great mistake to carry the small tables to six or seven places of decimals. Without any valuable increase of accuracy, they are thus rendered clumsy and inconvenient. Tables of seven places should be proportionately extensive, as the large ones of Taylor; while those of six places are of little value,—for they are not delicate enough for the higher orders of calculation, and are not needed for inferior operations; but on the contrary, the disproportionate labor of using them destroys that brevity of computation which is the sole recommendation of logarithms."

The logarithmic tables in Bowditch's "Useful Tables" are a model of convenience, old as they are (except that in logarithms of numbers, each page should only contain even fifties), and the peculiar type assists the eye in readily catching the figures.

Our correspondent anticipates precisely what it had been intended to do in the tables for this field-book, viz., to first discard 6-place tables utterly, as an abomination which ought never to have been put into type, and still less multiplied indefinitely and preferred to all others, as has been the case in nearly all mathematical text-books in English; and secondly to improve their form typographically, first, by using the old-style figures, which for years have been almost universal in German table-books, but as yet are the rare exception in English books; and secondly, by copying and in some respects improving on the typographical arrangement of the tables on the page, so that the spacing, grouping, and rules may relieve the eye and mind from strain, by making the selection of any number on the page as much as possible a mechanical process. As the subject is one of general interest and importance, we may make the above letter the text for an editorial on logarithmic and other tables in some future issue, but will not further discuss it here.

PORTABLE TRAMWAYS IN INDIA.—One of the first experiments in India in the use of a portable tramway for the carriage of forest produce is now being tried in the Anamalais, where a line has been laid down under the orders of the Madras Government. A line of about three miles will shortly be laid on a section of the Chittagong Demagiri road.

RAILWAYS.

EAST OF CHICAGO.—Existing Roads.

Ohio & Mississippi.—G. M. WALKER, of Mitchell, Ind., Engineer in charge of construction, informs us that work is now in progress on the Cincinnati & Bedford Ry., which is to run from Rivervale, Ind., to the Bedford stone quarries on the Tanyard Branch, 6½ miles. The line is to be completed early in the spring of 1890.

Montreal & Western.—A correspondent writes us as follows:

This railway begins at St. Jerome, P. Q., the terminus of the St. Jerome Branch of the Canadian Pacific R. R. and is to run in a northwesterly direction through the county of Terrebonne to La Chute aux Iroquois on La Riviere Rouge, a distance of about 70 miles. The work of construction was begun about Nov. 15, and the first 10 miles are under contract. Tracklaying will be commenced early next summer, and the entire 10 miles, it is expected, will be completed by the close of 1890. An arrangement has been made by which the Canadian Pacific R. R. will operate the road as soon as completed, section by section. The officers of the company are: E. D. ROLLAND, President; H. J. BEEMER, Managing Director; E. RODIER, Secretary, and G. H. GARDEN, Chief Engineer.

Central Ontario.—A press dispatch from Ottawa, Ont., states that the Dominion Government will be asked for a subsidy of $6,000 per mile for this company's proposed extension from Coe Hill to Sudbury, Ont., a distance of 200 miles.

Cincinnati Midland.—A meeting of the stockholders of this company will be held Jan. 3 to consider the lease of the line to the Central Ohio R. R. Co.; to take measures as to increasing the capital stock of the company to $1,000,000 and making the same preferred stock in order to meet its obligations, and as to extending the present mortgage of the company 25 years from its expiration.

Louisville, New Albany & Chicago.—The company has placed aside $770,000 for further improvements. About $500,000 of this will be used in purchasing new equipment, and the remaining $270,000 will be used in increasing the terminal facilities at Indianapolis, Ind., and in making other improvements.

Drummond County.—This road has been completed and opened for traffic from Drummondsville to Nicolet, P. Q., a distance of 34 miles. It is stated that the line will be extended from Drummondsville to St. Hyacinthe in the spring.

Chateaugay.—This company is building a 2-mile branch from Plattsburg, N. Y., to Maine Mills, to bring out the large amount of lumber made there.

New York, Ontario & Western.—The announcement that the VANDERBILTS were securing proxies from the stockholders of this company has given rise to the rumor that they intended to absorb the road and build additions to develop the coal fields along the route. The N. Y., O. & W. is now building a line to tap the Wyoming coal fields at Scranton, Pa. According to the report the VANDERBILTS will build a line from Scranton westward to a connection with the Beech Creek R. R., at Williamsport. The Beech Creek road, which is now controlled in the VANDERBILT interest, passes through some of the finest bituminous coal regions in Pennsylvania. The plan is to build a line from the western terminus of the Beech Creek road to Oil City, Pa., where connection would be made with a branch of the Lake Shore & Michigan Southern R. R. By carrying out this plan a short line to both the east and west could be secured for the heavy coal traffic commanded by the Beech Creek R. R.

Toledo, Ann Arbor & North Michigan.—Civil Engineer, J. H. BLOOMSHIELD, has just completed the location of the extension of the Toledo, Saginaw & Mackinaw R. R. from East Saginaw, Mich. to Tawas City. The line passes through Bay City, Saginaw, Pine River, Au Gres, Arenac, Harmon City, and Alabaster.

Temiscouata.—At a meeting of the stockholders recently held, the following directors were elected: JOHN J. MCDONALD, HECTOR CAMERON, Hon. GEORGE IRVINE, Dr. GRANDBOIS, M. P., WM. MCCARTHY, J. ISRAEL TARTE, and R. RYAN. The nomination of Mr. Th. CROCKETT as General Superintendent was confirmed. At a meeting of the directors, Mr. J. J. MCDONALD was elected president, and Mr. HECTOR CAMERON, Q. C., Vice-President. The road has been opened for business from Riviere du Loup, P. Q. to Edmundston, N. B., a distance of 81 miles.

Concord & Montreal.—The excavation of the line from Franklin to Tilton, N. H., 4 miles, has been completed and it is stated that construction will soon commence.

Shore Line, (N. B.)—A press dispatch states that the owners of the Shore Line railroad in New Brunswick are taking steps to connect their road with the shore line in Maine. A petition is to be presented to the next New Brunswick Legislature for a charter for a bridge across the St. Croix River at Calais.

Easton & Northern.—A press dispatch from Easton, Pa., says that this company has decided to adopt the plan of tunneling under Easton for a distance of nearly half a mile to reach a connection with the main line of the Lehigh Valley R. R. The tunnel will cost $86,000 exclusive of track, and to reach the Lehigh Valley depot will require a bridge and this will cost $64,000. The Lehigh Valley R. R. Co. has agreed to build this bridge. The Easton & Northern Co. will ask the citizens of Easton to take $50,000 worth of stock, the money to be used for constructing the tunnel. Until the tunnel is built the Easton & Northern will transport freight through Easton by horse-power, using street-car tracks.

Projects and Surveys.

Dunderburg Spiral.—H. J. MUMFORD, of Mauch Chunk, Pa., has sent us the following information concerning this enterprise:

The road is to start from Jones' Point on the Hudson River, ascending Dunderberg mountain by two inclined planes to an elevation of 1,200 ft. and running thence by a circuitous route to the starting point, a distance of about 15 miles. The inclined planes will be operated by stationary engines and cables and the descent from the top will be made by gravity. The grade of the road will be about 90 ft. per mile, exclusive of the incline, which will have a grade of 1,500 ft. per mile. There will be one tunnel 300 ft. long. The surveys for the line have been completed and the right of way secured. Contracts for construction will probably be let in January or February, and the road is expected to be completed and in operation by May, 1891. The road is being built by a company of New York and Pennsylvania capitalists among whom the prime movers are T. L. MUMFORD and H. J. MUMFORD, of Mauch Chunk, Pa., who lease and operate the Mauch Chunk, Summit Hill & Switchback R. R. The principal business of the road will be in the pleasure travel from New York and vicinity. The company was incorporated Nov. 9, 1889. The officers are: President, JAMES MORGAN; Chief Engineer, ISA E. HARTWELL, of Wilkesbarre, Pa.

Indianapolis & Columbus.—A press dispatch from Louisville, Ky., states that a company has been formed to build a railway parallel to the Jeffersonville, Madison & Indianapolis from Columbus, O. to Indianapolis, Ind. Money for the preliminary surveys is said to have been secured.

Grand View Branch.—It is announced that this company will build a railway from Ontario Beach to Manitou Beach, N. Y., along the shore of Lake Ontario. The length of the road will be 6 miles.

Phoenixville & Allentown.—A project is on foot to build a railway from Phoenixville to Allentown, Pa. THOMAS J. B. RHOADS, of Boyertown, Pa., is interested.

SOUTHERN.—Existing Roads.

West Virginia Central.—This company is considering building a line from Cumberland, Md., to a connection with the Western Maryland R. R. at Hagerstown. The object of the road is to obtain a shorter line to Baltimore, Md., for its coal traffic.

Louisville & Nashville.—Surveys are reported in progress for the line from Clarksville to Dickson, Tenn., a distance of about 60 miles. It is intended to commence construction as soon as possible and have the line completed and in operation by January, 1889. The line will be known as the Dickson Division of the Louisville & Nashville R. R. Construction is in progress on the 10-mile branch to Grace's, Ala. Surveys are in progress for a line from Carpenter's Station, Ala., to the property of the Napier Iron & Mining Co., a distance of 11 miles.

Nashville, Florence & Sheffield.—The 2-mile extension of this road to Sharp's ore banks, has been completed by the contractors, Davis & Canty.

Norfolk & Western.—This company has located a branch up Big Creek leaving the Clinch Valley Division at Richlands, about 42 miles west of Bluefield, W. Va. This branch, which will be 4 miles long, is being built to open up the extensive coal deposits located along the creek and owned by the Clinch Valley Coal & Iron Co. The construction of the line will begin soon.——Mortgages are being filed in the counties along the route of the proposed extension to Ironton, O. The line has been located and the engineers are now at work on the plans for the bridge across the Ohio River at Ceredo, W. Va. It is stated that construction will commence in the spring.

Chesapeake & Ohio.—It is announced that this company will build a branch from Clifton to the Warm, Hot and Healing Springs of Virginia, a distance of 22 miles.

Anniston & Atlantic.—This 52-mile road running from Anniston to Syllacauga, Ala., has been sold to the Queen & Crescent System, according to a press dispatch.

Union R. R. Bridge & Terminal.—Work has been commenced on the double-track tunnel, 2,400 ft. long at Wheeling, W. Va.

Jacksonville, Williamsport & Anniston.—A press report states that the contractors have commenced work on this road, which is to run from a point on the East & West R. R. of Alabama, via Jacksonville to Anniston, Ala. The length of the road with its branches will be about 20 miles.

Atlantic Coast Line.—At the annual meeting of the stockholders of the Wilmington & Weldon R. R. Co., recently held, the following officers were elected: B. F. NEWCOMER, President, H. WALTERS, Vice-President and General Manager; JNO. R. KENLY, Assistant General Manager; JAS. F. POST, Jr., Secretary and Treasurer; JAS. F. DIVINE, General Superintendent, and W. A. RIACH, General Auditor. The heads of other departments remain as formerly, viz: T. M. EMERSON, General Freight and Passenger agent, and B. R. DUNN, Engineer of Roadway.

General Manager WALTERS in his report says: The Scotland Neck Branch has been extended during the year to the Tar River, opposite Greenville, and the bridge and trestle to cross the river is now under contract. The extension of this branch to Kingston or Newbern, it is hoped, will be accomplished during the coming fiscal year. Beyond that point I would not recommend any further extension for the present. The Albemarle & Raleigh Railroad has been extended 22 miles to Plymouth, and connects at Jamesville with the Jamesville & Washington Railroad, which, however, I regret to record, is in such a condition that but little freight or passenger business can be transported over it to Washington. A branch could be built from near Greenville to Washington for about what it would cost to put the Jamesville & Washington Railroad in proper condition, and such a location would much better suit the business.

Projects and Surveys.

Yadkin.—We have received the following information from THEO. F. KLUTZ, of Salisbury, N. C., President:

The road is to run from Salisbury, via Gold Hill, Bilesville, and Albemarle, to Norwood in Stanly County, a distance of 42 miles. The right of way has been secured, and other local aid to the amount of $160,000 has been subscribed by Rowan and Stanly Counties. The preliminary surveys for the line are now being made and location will commence as soon as these are completed. Construction will commence as soon as the line is located, and it is expected that the road will be completed by Jan., 1891. The road is being built as a feeder to the Richmond & Danville R. R., and will ultimately be extended to a connection with the Carolina Central R. R. at Wadesboro or Buckingham. Major GORDON, of Salisbury, is Chief Engineer.

Southern Coal, Iron & R. R. Co.—At a meeting recently held the following officers were elected: President—Hon. CHARLES GRANT Jr.; First Vice-President and Chief Engineer, L. C. WOLKINS; Second Vice-President, H. A. ARMSTRONG; Treasurer, WM. C. COLCORD; Secretary, CHARLES E. WILLARD; Clerk, S. A. LENCKEY. The capital stock of the company is placed at $5,000,000. The offices of the company are now at 74 Tremont St., Boston, but will shortly be moved to 620 Atlantic Ave. Boston. Offices will also be established at Morristown, Tenn., where after Jan. 21, 1890, proposals will be received for constructing portions of the proposed lines.

Washington, Alexandria & Fairfax.—A bill has been introduced into the Virginia Legislature to incorporate this company to build a railway from Alexandria to Falls Church, Va., and beyond. Among the incorporators are: F. K. WINDSOR, LOUIS C. BURLEY, RALPH J. THOMAS, and JOHN CHRICHEN, Jr.

Tennessee Valley.—A railway company by this name has been incorporated in Tennessee.

Atlantic, Alleghany & Western.—Chartered in Virginia to build a railway from a point on the West Virginia State line either in Highland, Augusta or Buckingham Counties to some point on the Potomac, Rappahannock, or York Rivers. Among the incorporators are: FRANCIS A. FRENCH, H. D. GARDEN, and GEO. H. SEWERS, of New York City.

NORTHWEST.—Existing Roads.

Great Northwest Central.—J. H. E. SECRETAN, of Brandon, Man., Chief Engineer, send us the following information:

The road is to run from Brandon, Man., via Rapid City to Battleford, a distance of 450 miles. The route is through a prairie country affording generally light work; maximum grade 60 ft. per mile, and maximum curve 6°. There will be two bridges, 1,100 ft. and 2,900 ft. long respectively, across the North and South branches of the Saskatchewan River. The contract for 100 miles of the road has been let to A. Charlebois, of Quebec, P. Q.,

who has completed 50 miles of the line northwest from Brandon and now has a force of about 250 men at work on the remaining distance.

Canadian Pacific.—Tracklaying is now in progress on the Qu' Appelle, Long Lake & Saskatchewan R. R. The road has been graded for 130 miles which brings the line to within a few miles of the Saskatchewan River. A large force of men and teams are now at work near Prince Albert getting out ties and bridge timbers.

Northern Pacific.—Engineers are at work making a survey for a branch from Red Lake Falls, Minn. to West Lynne, Man.——This company has acquired possession of the Duluth, Crookston & Northern R. R. recently completed from Crookston to Fertile, Minn., a distance of 23 miles.

Projects and Surveys.

Kearney, Hutchinson & Gulf.—Incorporated in Nebraska to build a line of railway from Kearney, Neb., to Galveston, Tex. Among the incorporators are: F. G. ROBERTSON, H. J. ALLEN, H. C. ANDREWS and others of Nebraska.

Omaha & Forest City.—A project is on foot to build a railway from Omaha, Neb., to Forest City, S. D. Mr. R. M. SPRINGER, of Forest City, is interested.

Gull Lake & Northern.—Incorporated in Minnesota to build a line of lumber railway from Gull Lake, Cass County, into the timber lands owned by Messrs. PILLSBURY, GEO. A. PILLSBURY, of Minneapolis, Minn. is President.

Chicago & Southeastern.—Incorporated in Illinois to build a railway from Chicago to a point on the Indiana State line in the township of Thornton. Among the incorporators are: ADAM A. GOODRICH, of Jerseyville, Ill. EUGENE HUTCHINS and FRANK H. BOWEN, of Chicago.

Saskatchewan & Colonization.—This company seeks incorporation to build a railway from Portage La Prairie to Westbourne, Man., with branches to Prince Albert and Lake Winnipeg.

Sioux City & Northwestern.—At a meeting of the directors recently held the following officers were elected: President, JOHN PIERCE; Vice-President, W. L. JOY, Secretary, F. S. BUTLER; and Treasurer, H. A. JOHNS. The road will, it is stated, be built to Livermore, Ia., next year.

St. Louis & Illinois Central.—Chartered in Illinois to build a railway from Eureka to Alhambra, Ill. Among the incorporators are: J. M. STARK, Pawnee, Ill.; H. W. DANA, Lincoln, Ill.; and ROBERT MCWILLIAMS, of Alton, Ill.

SOUTHWEST.—Existing Roads.

Louisiana North & South.—Grading has been finished on the line from Gibsland south to Sparta, La., 10 miles, and tracklaying is now in progress. It is expected that the line will be completed this month.

New Orleans, Ft. Jackson & Grand Isle.—Tracklaying will soon be completed on the 6 miles of this line through the swamp between Algiers and Bellechasse, La. Rails for the entire 65 miles of the road from Algiers to Ft. Jackson are on the ground and will be laid as fast as possible.

New Orleans & Northwestern.—This is the new name of the New Orleans, Natchez & Ft. Scott R. R. Work is in progress between Vidalia and Sicily Island, La., and it is expected that this portion of the line will be completed by Jan. 1.

Missouri Pacific.—The contract for building the line from Dermott, Ark., to Monroe, La., has been let to a Mr. Jackson, of Kansas City, Mo. The contractor is now shipping his outfit and work will commence at once.

Baltimore & Ohio.—The report is again in circulation that this company will extend its line to the Missouri River at St. Joseph.

Kansas City, Rich Hill & Eldorado.—Work is reported in progress between Eldorado and Walker, Mo., This section of the road is to be completed in 60 days.

Kansas City, Wyandotte & Northwestern.—A press report from Beatrice, Neb., states that the Kansas City & Beatrice R. R will be completed by Dec. 16.

San Antonio & Aransas Pass.—The location of the line from Kennedy to Laredo, Tex., has been completed.

Eureka Springs.—It is reported that arrangements have been completed for an extension of this road from Eureka Springs south to Little Rock, Ark., and from Seligman north to the coal fields of southeastern Kansas.

Projects and Surveys.

Doniphan.—Surveys are reported in progress for a railway by this name to run from St. Joseph, Mo., to Joplin, Mo., and thence south into Arkansas. Col. JOHN DONIPHAN, of St. Joseph, is at the head of the enterprise.

Kansas City, Bentonville & Southern.—Chartered in Arkansas to build a line of railway 130 miles long. The capital stock is $1,550,000.

ROCKY MT. AND PACIFIC.—Existing Roads.

Oregon Improvement Co.—It is stated that the proceeds of the $15,000,000 of bonds recently issued by this company will be used in changing the Columbia & Puget Sound R. R., running from Seattle to Franklin, Wash., 33.6 miles, to standard gauge and extending the road east over the Cascade Mountains to a connection with the lines of the Oregon Ry. & Navigation Co.

Union Pacific.—Kilpatrick Bros. & Collins, of Beatrice, Neb., have the contract for building the first 120 miles of the Los Angles extension from Milford, Utah, to Pioche, Nev. This portion of the line is to be completed by July 1, 1890. The contract for changing the gauge of the Utah Northern R. R. has been awarded to the same company.

Denver, Texas & Ft. Worth.—Contracts are reported let for the extension from Long's Cañon to Las Vegas, N. M.

Spokane Falls & Northern.—This company will seek a charter at the coming session of the British Columbia Legislature, to build a railway from the mouth of the Pend d'Oreille River near the International boundary, to Nelson, on Kootenai Lake, B. C.

Denver & Rio Grande.—D. D. Streeter, who has the contract for building the Tennessee Pass Tunnel, has commenced work. The tunnel will be 2,500 ft. long.

Projects and Surveys.

Portersville & Tulare.—Incorporated in California to build a railway from Portersville to Tulare, Cal., 22 miles. Among the incorporators are: PHILIP H. LILIENTHAL, W. H. CHICKERING, and LEON SLOSS Jr.

Arizona.—The people of Maricopa County, Ariz, have raised $260,000 in aid of the proposed road from Phœnix to a connection with the Atlantic & Pacific R. R.

Brownsville & Albany.—A project is on foot to build a line of railway from Albany to Brownsville, Ore. and also a line from Brownsville up the Calapooya River.

RAPID TRANSIT.

Electric Railways.—*Greenbush, N. Y.*—The North & East Greenbush Ry. Co. has been granted permission to erect poles and wires for operating the line by electricity.

Newark, N. J.—The Council has been discussing the overhead wire and storage battery systems.

Lancaster, Pa.—A New York syndicate, headed by SUMNER T. DUNHAM, has purchased the East End and Lancaster City lines, and will put in an electric system.

Nashville, Tenn.—The United Electric Ry. Co. has been incorporated by the syndicate which has acquired the street railways. Among the directors are G. M. FOGG, I. T. RHEA, T. W. WRENNE, W. C. DIBELL, FRANK MORROW and others.

Atlanta, Ga.—The street committee has made a favorable report on the petitions of the Union Street Ry. Co. for power to adopt electric traction.

East Liverpool, O.—The street railway company will probably adopt the Thomson-Houston electric system.

Indianapolis, Ind.—The Citizens' St. Ry. Co. has contracted with the Thomson-Houston Co. for electric plant and equipment.

Springfield, Ill.—The Springfield Street Ry. Co. has applied for power to operate its road by electricity, using overhead wires.

Denver, Col.—Contracts for the Colfax Ave. electric line have been let to the Sprague Electric Co. and the Edison Ry. Co. James Swem has the contract for tracklaying. The road will cost $80,000, and is to be completed by February.

Vancouver, B. C.—The Vancouver St. Ry. Co. and the Vancouver Electric Illuminating Co. propose to put in a joint plant for light and power.

Elevated Railway.—*Brooklyn, N. Y.*—The Union Elevated Ry. Co. proposes to build an extension on 3rd Ave. from 27th St. to Fort Hamilton.

Cable Railways.—*Baltimore, Md.*—The Baltimore Traction Co. will soon have work commenced on its cable conduits. Mr. F. H. HAMBLETON is the engineer; Mr. A. D. WHITTON is engineer of the U. S. Construction Co., which has the contract for construction; the Pennsylvania Iron Works have the contract for machinery; and Mr. HENRY BRAUNS is the architect for the two power houses.

Denver, Col.—The Larimer St. cable line is to be extended eastward half a mile.

Oakland, Cal.—The Central Ave. Cable Co. has been incorporated by M. H. GROSSMAYER, T. WAGNER, J. F. ENGLISH, and others. Capital stock, $1,000,000.

Dummy Lines.—*McMinnville, Ore.*—A company is being organized to build a motor line to Dayton and other neighboring towns.

Hanford, Cal.—A motor line to Fresno is projected.

Port Townsend, Wash.—A company has been organized by R. S. MILLER, HENRY LANDES, H. L. BURKETT, and others, to purchase the motor line and build 5 miles of extensions.

Street Railways.—*New York, N. Y.*—The Metropolitan Crosstown Ry. Co. has been granted a franchise for a line from Grand St. ferry to 14th St.; connecting with the 23th and 29th Sts. line.

Bellaire, O.—The street railway has been requested to extend its lines, and the citizens have raised subscriptions for the purpose.

Durham, N. C.—The street railway has been sold at auction. It was purchased by Major W. A. GUTHRIE for $2,750 for the track, etc.; $350 for the stables, and $240 for four cars.

Pueblo, Col.—The Pueblo City Ry. Co. has been incorporated by J. N. CARLILE, WM. CREEK and J. F. VAILCapital stock, $500,000. Cable or electric traction may be employed.

Springfield, Ill.—The People's Gas Motor Ry. Co. has been incorporated by CHARLES SCHUCK, FRANK REISCH and CHARLES F. HERMAN. Capital stock, $50,000. It is proposed to use the Connelly gas motor.

Salem, Ore.—The Capital City Ry. Co. has increased its capital stock from $25,000 to $50,000.

HIGHWAYS.

New Jersey.—The Bergen County Board of Freeholders has decided to begin to make county roads under the new law. The road from Hohokus to Paterson, 3 miles long, was first accepted. It will cost $15,000 to macadamize it. This is an entering wedge of a proposed plan to spend $50,000 a year on county roads. ——Several Camden County farmers have appealed to the Judge of the Interior Court for the appointment of a County Board of Surveyors to lay out a 66 ft. roadway in Stockton Township. The application was made for an outlet from the country over the new Knight Ave. Bridge to Camden.

Virginia.—A determined effort will probably be made at the approaching session of the Legislature to improve the public roads. Mr. S. WELFORD CARDIN, of King George County, chairman of the sub-committee of the State Board of Agriculture, is busily employed, it is said, in preparing bills to be submitted to the General Assembly looking to an improved system of county roads. The suggestion is that the labor for these should be supplied by the younger and less hardened State criminals.

Long Island.—The highways of the town of Huntington are hereafter to be worked by contract. It was voted to do so by the town a year ago last spring, but the matter was delayed and nothing done toward changing the system. The Commissioners of Highways had the matter put to vote at the last spring election, and the people of the town again decided in favor of the system. The Commissioners now have no other alternative, and the contract system will go into effect as soon as the bids can be received and considered.——A convention was held at Jamaica recently and attended by men from every part of Queen's County, to discuss the subject of road improvement. There is a good prospect that the conference will bring forth excellent fruit. Those present favored the county road system, voting almost unanimously for macadamizing as a means of improvement.

New York.—The Board of Supervisors of Bedford, has authorized the raising of $6,473.80 for the repair of roads and bridges in this town.

CONTRACTING.

Macadamizing.—The following proposals have been received for a macadam road at the National Cemetery, Natchez, Miss.: John Conner, Natchez: grubbing and clearing, $30; excavation, 18 cts. per cu. yd.; borrowed embankment, 20 cts. per cu. yd.; screened gravel, $1.15 per cu. yd.; unscreened gravel, 70 cts. per cu. yd.; brick laid, $16 per M; lumber, $17 per M. J. P. Whitmarsh, Natchez: grubbing and clearing, $50; excavation, 18 cts.; borrowed embankment, 20 cts.; screened gravel, $1.15; unscreened gravel, 75 cts.; brick laid, $16.90; lumber, $19. O'Brien & Co., Natchez: grubbing and clearing, $25; excavation, 18 cts.; borrowed embankment, 20 cts.; screened gravel, $1.15; unscreened gravel, 70 cts.; brick laid, $14.35; lumber, $16. The contract was awarded to O'Brien & Co.

A contract has been awarded to James Frazier, of Wheeling, W. Va., for improving the Wheeling and Fairmont road, at $1.10 per cu. yd. for macadamizing and 25 cts. per cu. yd. for grading.

Jail.—The contract for the new jail at Opelika, Ala., has been awarded to the Pauly Jail & Mfg. Co., of St. Louis, Mo., at $10,500.

Paving Supplies.—The contract for supplying basalt blocks for San Francisco has been awarded to J. W. McDonald at $35.90 per M.; gravel, 73 cts. per ton; brick, $11.60 per M. The contract for supplying cement was awarded to H. T. Holmes Lime Co. at $3.59 per bbl. for Gillingham's; $3.69 per bbl for Knight's.

Culvert.—Bids for the construction of a culvert at Holley, N. Y., were received Dec. 6 by JAMES SHANAHAN, Superintendent of Public Works, Albany, N. Y., but they exceeded the appropriation, and the contract was not awarded.

Removing Ledge.—The following proposal for removing ledge in the harbor at Boston, Mass., was received Dec. 7, by Lieut.-Col. S. M. MANSFIELD, U. S. Engineer Office, Boston, Mass.: Geo. W. Townsend: $29 per cu. yd., measured in place.

Elevators.—The contract for the elevators in the new post-office building at Baltimore has been awarded to the Crane Elevator Co., of Chicago, for $27,320. There were four competitors. A Boston concern bid $16,000, Ellithorpe, of Chicago, bid $17,200, and Otis Bros., of New York, also made a bid.

Concrete Pavement.—The following proposals for the new concrete pavement at Tompkins Park have been received by the Park Commissioners, Brooklyn, N. Y.: Matthew Taylor, 23½ cts. per sq. ft.; Wilson, Boller & Co., 23 cts.; Blaney & Co., 25 cts.; Schellinger & Co., 27 cts.; Chrystie & Co., 28 cts.

Jetties.—The contract for jetties and shore protection for the light station at Cape Charles, Va., has been awarded to T. H. Hathaway & Co., Philadelphia, Pa., at $16,250.

Well.—The San Joaquin County (Cal.) Board of Supervisors has awarded the contract for a 10-in. gas well, 2,000 ft. deep, to J. K. McPherson, at $6,000; the prices are $2.25 per ft. for the first 1,000 ft.; $3.25 per ft. for 500 ft.; $4 per ft. for 250 ft.; and $4.50 per ft. for the last 250 ft.

Street Work—*Brooklyn, N. Y.*—The only proposal for grading and paving Harmon St. was from Charles Hart, at $12.21 per lin. ft. Bids for flagging sidewalks were as follows: Henry Mogk, 22½ cts. per sq. ft.; John Morrissey, 19¾ cts.

Bulkheads.—The following proposals have been received by the Commissioner of City Works, Brooklyn, N. Y., for repairing the bulkheads at Union St. bridge: Hugh Hart, square timber faces, $1,700, stone retaining walls, $2,300; Barth S. Cronin, square timber faces, $1,740 stone retaining walls, $1,740; John D. Walsh, square timber faces, $1,819, stone retaining walls, $2,700; Patrick H. O'Connel, square timber faces, $1,644; Stephan A. Kelly, square timber faces, $1,430, stone retaining walls, $1,475; John W. Flaherty, square timber faces, $2,700; James Du Bois, square timber faces, $1,887; stone retaining walls, $2,559.

PROPOSALS OPEN.

Removing Building.—Taking down and removing from the grounds the immense stone structure known as the Chicago University Building, on Cottage Grove Ave., near 34th St., the contractor to keep all the material and the same to be taken down and removed within 60 days after letting of contract. Work can be commenced Jan. 1. JOHN WAIN, Tacoma Building, or D. G. HAMILTON, 94 Washington St., Chicago, Ill.

Barge and Scows.—One barge for patent dredger, and four scows. A. CHIPMAN SMITH, Director, Department of Public Works, St. John, N. B. Dec. 17.

Tugboat.—Construction of a tugboat; plans and specifications prepared by WM. COWLES, 45 Broadway. CHAS. F. ALLEN, President, Quarantine Commissioners, 71 Broadway, New York City. Dec. 17.

Inlet Tunnel.—At Chain of Rocks: 1,800 cu. yds. of earth excavation, 700 cu. yds. of rock excavation in shaft, 4,700 cu. yds. of rock excavation in tunnel, 2,800 cu. yds. of brick masonry, 15 cu. yds. of stone masonry, 25 cu. yds. of concrete, 11,000 ft. B. M. lumber. Plans and specifications on file. HENRY FLAD, President, Board of Public Improvements, St. Louis, Mo. Dec. 17.

Inlet Tower.—At Chain of Rocks: 30 cu. yds. of rock excavation in shaft (without explosives); 70 cu. yds. of rock excavation in shaft (with explosives); 35 cu. yds. of brick masonry; 565 cu. yds. of stone masonry, class Y; 235 cu. yds. of granite masonry, class H; 425 cu. yds. of granite masonry, class I; 108 lin. ft. of cornice; setting iron work and gates; 8,500 lbs. cramps, dowels, and anchor bolts. Plans and specifications on file. HENRY FLAD, President, Board of Public Improvements, St. Louis, Mo. Dec. 17.

Bridge.—Rebuilding and placing in proper position the draw span in the Central or Macomb's Dam bridge over the Harlem River. THE COMMISSIONERS OF PUBLIC PARKS, 49, 51 Chambers St., New York City. Dec. 18.

Fencing.—D. POTTINGER, Chief Superintendent, Intercolonial Ry., Moncton, N. B. Dec. 21.

Bridge.—Automatic self-closing swing bridge over canal at Benson St., Lockland; also for the iron pile substructure for same, in Springfield Township. THE COUNTY COMMISSIONERS, Cincinnati, O. Dec. 21.

Electric Lighting.—For a term of 1, 2 or 3 years from July 1, 1890. JOHN B. MOLONY, Controller, Detroit, Mich. Dec. 21.

Excavation and Cement.—Excavation for boiler room and coal vaults and removal of earth beans, and also furnishing and delivering 12,000 bbls. of natural hydraulic cement for the building for the Library of Congress. BERNARD R. GREEN, Superintendent and Engineer, 145 E. Capitol St., Washington, D. C. Dec. 23.

Asphalt Paving.—On concrete foundation, and on the present stone pavement. THE COMMISSIONERS OF PUBLIC WORKS, 31 Chamber St., New York City. Dec. 23.

Dredging.—Dredging and removing bars, etc., from Cuyahoga River, the old river bed and Sycamore St. slip. W. P. RICE, City Engineer, Cleveland, O. Dec. 24.

Dredging.—In the Virginia channel of the Potomac at Washington. Lieut. Col. PETER C. HAINS, U. S. Engineer Office, Washington, D. C. Dec. 30.

Bridges.—Iron highway bridge, also iron foot bridge. OTTO THOMAU, Comptroller, New Orleans, La. Dec. 31.

Sewers.—Brick sewers. THE DISTRICT COMMISSIONERS, Washington, D. C. Jan. 2.

MANUFACTURING AND TECHNICAL.

Market Prices.—*Rails.*—New York; $35. Pittsburg; $35 to $36 at mill; this price is expected to go higher unless the cost of Bessemer pig is reduced; old rails, $22.50 to $23.50 for steel, $28 for iron. Chicago, $37 to $37.50; old rails, $20.50 to $21 for steel, $20.50 for iron.

Track Material.—Pittsburg, spikes, $2.15 or $2.25 at Chicago, Milwaukee, St. Louis or Cincinnati; splice bars, 2 cts.; track bolts, 3.10 cts. with square, and 3.20 cts. with hexagon nuts. Chicago; splice bars, 2.25 cts steel, 1.95 to 2 cts. for iron; spikes, 2.25 to 2.30 cts.; track bolts, 2.80 to 2.90 cts. with square, 2.95 to 3 cts. with hexagon nuts.

Structural Iron.—New York: iron universal mill and tank plates, 2.25 cts. to 2.30 cts.; iron angles, 2.25 cts. to 2.3 cts.; tees, 2.75 to 2.8 cts; beams and channels, 3.1 cts. on dock. Pittsburg: angles, 2.45 cts; tees, 2.95 cts.; beams and channels, 3.10 cts; sheared bridge plates, steel, 2.85 cts.; universal mill plates, iron, 2.55 cts; refined bars, 2 cts.; tank iron, 2.40 cts. to 2.45 cts. for iron, and 2.65 cts. to 2.75 cts. for steel. Chicago: angles, up to 5-in., 2.35 cts.; over 5-in., 2.45 cts.; tees, 2.85 cts. to 3 cts.; universal plates, 2.35 cts. for iron, and 2.45 cts. for steel, up to 16 ins. wide, and 2.55 cts. from 16 ins. up; sheared bridge plates, 2.45 cts. Carload lots of beams and channels are 3.20 cts., Chicago. Small lots from stock of angles, 2.70 cts. to 2.75 cts., tees, 3 cts.; beams and channels, 3.70 cts.

The Strong Locomotive.—The Strong engine has been running on the Cincinnati division of the Cleveland, Cincinnati, St. Louis & Chicago, and is said to have recently had a short race with one of the big passenger engines on the Ohio & Mississippi. Twelve miles out of Indianapolis, each hauling heavy express trains, they came up side by side, and between that point and the Grand Central Station there was some lively running, but the Strong locomotive distanced the O. & M. engine about two miles in running twelve. The engine is now running on the Cincinnati, Hamilton & Dayton.

Electric Headlights.—The National Electric Headlight Co., of Indianapolis, Ind., is having one of its lights tried on a Vandalia engine. A 3 H. P. engine and dynamo, weighing about 700 lbs., is mounted on the extension front, between the smoke-stack and headlight.

The Carolina Oil & Creosote Co., of Wilmington, N. C., has recently shipped a third cargo of timber to the Nicaragua Canal Co. It consists of 131 creosoted piles, valued at $1,432.35; 108 pieces creosoted lumber, valued at $2,014.43; 393 non-creosoted piles, valued at $540.40; 28 pieces non-creosoted timber, valued at $307.33. Total value, $4,294.31.

Gas Works for Sale.—The St. Louis Gas Light Co., of St. Louis, Mo., will sell its gas plant at auction on Dec. 24. The plant includes land, station works, gas holders, mains, etc. The number of cubic feet of gas sold by the St. Louis Gas Light Co. for private and public consumption during the twelve months ending Oct. 31, 1889, was about 498,000,000.

Locomotives.—The Schenectady Locomotive Works, of Schenectady, N. Y., have an order for 10 consolidation engines for the Chesapeake & Ohio. They will have cylinders 21 x 44 ins., and will weigh 30,000 lbs.

The New York, Lake Erie & Western has received 12 new engines.

Adams & Price, of Nashville, Tenn., have built a patent logging engine and 9 cars for C. C. Mengel & Co., of Louisville, Ky.

Cars.—The Riordan Refrigerator Car & Transportation Co. has been incorporated by WINTHROP POND, CHARLES R. KAUFMAN, and GEORGE R. KATTEL, of New York City; MORRIS R. LOCKE, of El Paso, Tex; and JAMES L. PENNIFIELD, of Chicago. Capital stock, $2,000,000.

Haskell, Barker & Co., of Michigan City, Ind., have a contract for 500 cars for the Columbus & Hocking Valley.

The Michigan Car Co., of Detroit, Mich., has an order for 200 freight cars for the Flint & Pere Marquette.

The Indianapolis Car Co., of Indianapolis, Ind., built 598 cars during November; 50 per cent. were box cars and the remainder coal and flat cars.

The Cleveland, Cincinnati, Chicago & St. Louis has now 300 new stock cars, all equipped with automatic couplers and air brakes. They are 34 ft. long, and rest on substantial trucks. It will be safe to run a train of them at a speed of 40 miles an hour.

The Northern Pacific has ordered 100 new refrigerator cars for the spring business. They are to be standard cars, and have all the latest and improved appliances.

Hoisting Plant.—Mr. F. E. RAINER, General Manager of the Western branch house of the Lidgerwood Mfg. Co., at 34 and 36 West Monroe St., Chicago, Ill., reports a brisk demand throughout the West for the company's standard hoisting machinery.

Filters.—The National Water Purifying Co. has recently secured some large contracts for National filters, including the size of 20 ft. diameter, capacity 1,000,000 gals. each. The company claims to be the only filter company manufacturing such large mechanical filters, operating under pressure.

The Sicilian Asphalt Paving Co., New York, has purchased the asphalt business of Mr. HENRY BOLZE, of this city, and proposes to extend it considerably. The company will continue to use the natural Sicilian asphalt for street pavements, and the genuine Limmer asphalt, from Germany, for sidewalks, flooring, roofing, etc.; these asphalts have been used with success in Europe since 1877 and 1843 respectively, and by Mr. BOLZE in this in this country since 1886 and 1876 respectively, and are now controlled by this company for the United States and Canada. Besides the asphalt work, it will undertake the construction of artificial stone sidewalks, flooring, etc. The company has secured the services of Mr. BOLZE as General Manager of the practical part of the business.

Railway Plant and Machinery Wanted.—The Eureka Lumber Co., of Harlow, Ark., will purchase rails and an engine for a logging road.

R. C. Carter & Co., of Kimuigu, Ala., will want a 15-ton logging engine.

The Pierce & Torry Investment Co., of Orlando, Fla., wants a hoisting engine for hoisting cypress.

J. A. Devlin, of Due West, S. C., will build a dummy line 4½ miles long, and wants to purchase rails, rolling stock and an engine.

W. R. Burgess, of Greensboro, N. C., wants rails, splice bars, spikes, etc., for 5 miles of track.

A. Deslawners, of Providence, R. I., wants a 75 to 100 H. P. locomotive boiler.

H. G. Welty, Potomac Bridge Works, Frederick, Md., wants machinery for iron and steel bridge work.

BRIDGES AND CANALS.

Bridge Notes—*Woodsville, N. H.*—A new bridge is to be built by the Concord Ry. Co.

Providence, R. I.—The New York, Providence & Boston and Old Colony railways will widen the present bridge over the tracks at Smith St. to allow of the construction of four additional tracks. It will be an iron structure, 88 ft. span, with a 50 ft. roadway and two 15 ft. sidewalks.

Newark, N. J.—The Board of Freeholders of Essex County has appointed a committee of three to confer with a committee from the Hudson County Board of Freeholders in regard to the construction of a bridge over the Passaic at the foot of Chambers St., or some other point in the Twelfth Ward, to connect Newark and Harrison.

Pittsburg, Pa.—The South St. Bridge Co. is said to contemplate building a new structure, as the present suspension bridge could not safely carry the cable line which it is proposed to build on this route. The proposition was made to build an addition to each side of the bridge, especially for the cars, as is being done on the Smithfield St. bridge for the Birmingham cable line, but this plan does not seem to be very satisfactory.

Cumberland, Md.—The contract for the construction of the bridge over Wills' Creek has been awarded to the Pittsburg Bridge Co., of Pittsburg, Pa., for $1,559. It will be a high Pratt truss bridge, with two spans of 84 ft. each, a roadway 13 ft. wide; capacity 80 lbs. per sq. ft; factors of safety, 5 for compression, 4 for tension.

Fredericksburg, Va.—A bill will be introduced in the Legislature to authorize the town of Fredericksburg to issue $20,000 of bonds for the purpose of building an iron bridge across the Rappahannock.

Americus, Ga.—The Savannah, Americus & Montgomery Ry. will build a bridge across Montgomery St.

Vicksburg, Miss.—A bridge across the Tensas River, with a draw span 60 ft. wide, will be built by the New Orleans, Natchez & Fort Scott Ry. Co.

Denver, Col.—The following proposals for an iron bridge over Cherry Creek have been received by the Board of Public Works: Lane Bridge & Iron Works, Chicago, $14,792; King Iron Bridge & Mfg. Co., Cleveland, O., $15,849; Kansas City Bridge & Iron Co., $15,949; Wrought Iron Bridge Co., Canton, O., $16,200; Geo. E. King Bridge Co., Des Moines, Ia., $16,485; Bullen Bridge Co., Trinidad, Col., $16,489; Pittsburg Bridge Co., Pittsburg, Pa., $16,806; Milwaukee Bridge Co., $16,950; Penn Bridge Co., Beaver Falls, Pa., $17,485. The contract was awarded to the Lane Bridge & Iron Works.

Ceredo, W. Va.—The formal meeting of the Norfolk & Western Railroad officials and government engineers to examine plans for the proposed Norfolk & Western Bridge over the Ohio, was held at Cerredo, on Dec. 3, on the site of the proposed bridge. There were present: Chief Engineer COE, GEN. ENOCH, and Mr. DOANE, of the Norfolk & Western, and Col. W. E. MERRILL, Maj. AMOS STICKNEY, and Maj. D. W. LOCKWOOD. Mr. COE presented the plans of a steel bridge of five spans, the river spans of which will be 550 ft. long. It will be one of the finest railroad bridges on the river.

Houghton, Mich.—Mr. G. C. SHELDEN, Treasurer, states that the letting of the contract for the proposed bridge and approach has been postponed indefinitely.

Venice, Ill.—Iron work is being placed on the second span of the Merchants' Bridge to St. Louis. The span now being erected is over the center of the stream and main channel of the river.

St. Paul, Minn.—Mr. RUNDLETT, City Engineer, has reported, in regard to the bridge fund, that after the issue of $100,000 already provided for by the council, there will remain to the credit of the fund (after all work now under contract is provided for) about $60,000. A good part of this balance will be used in building the Selby Ave. bridge approaches, an improvement estimated to cost $38,000, on which the Board of Public Works has reported favorably. The bridge will be of iron and stone, with a 32-ft. roadway and 4-ft. sidewalk on each side.

Burlington, Ia.—A new wagon bridge over the Mississippi is projected.

New Orleans, La.—The government commission has been having arguments on the proposed Mississippi bridge. Several railways favor building the bridge below the city and two want it above the city. Steamboat men do not want it at all, unless it is made high enough

not to obstruct navigation. The commissioners are all opposed to locating a bridge above the city.

The Norfolk & Western R. R. Co. has let the contract for a batch of bridge work on the North Carolina extension to the American Bridge Co., of Roanoke, Va.

Canals.—*New York State.*—Contractors are already at work lengthening Erie locks numbered 23, 24, 25 and 26, situated between Schenectady and Pattersonville. The water is being drawn off.

Portage Lake.—A meeting of business men was held at Houghton, Mich., Nov. 30, at which a committee was appointed to draft a memorial to Congress asking that the Government take immediate steps to purchase and control the Portage Lake Ship Canal, as, owing to a lack of water at the entrances and in the canals and harbors of Lake Superior, loss of life and property has already been great, particularly during the present year.

ELECTRICAL.

Electric Light.—*Bethel, Me.*—The village has voted to issue $600 for lighting.

Middlebury, Vt.—Propositions have been made by the Thomson-Houston and Western electric companies.

Ipswich, Mass.—The Agawam Electric Co. has been incorporated with a capital stock of $10,000.

Mount Morris, N. Y.—The Citizens' Electric Light Co. has been organized. For particulars address GEO. W. PHELPS, Jr.

Cahlskill, N. Y.—The trustees have granted the franchise for lighting the village with electric lights to an Albany company.

Camden, N. J.—The American Subway Electric Co., of Camden, N. J., has been incorporated. Capital stock, $50,000. F. A. LEE and F. W. BROWN, of Philadelphia; F. B. ESLER, of New York; R. B. ESLER, Jr., of Ardmore, Pa.; and WILLIAM J. COITE, of Haddonfield.

Jersey City, N. J.—The Consumers' Gas Co. has been reorganized, and will put in an electric light plant.

Wheeling, W. Va.—The electric light question is under discussion, and the Council has appointed a special committee of one member from each ward to act in conjunction with the standing Committee on Lights and the Board of Gas Trustees, in the matter of formulating some plan for the introduction of electric light.

Clay City, Ky.—The Kentucky Union Land Co. has awarded a contract to the Edison Electric Light Co. for a plant of 1,000 lights capacity.

Savannah, Ga.—A contract has been made with the Brush Electric Light Co. to furnish the city 100 extra arc lights of 600 standard c. p. for the year 1890, and 200 arc lights of 600 standard c. p. for a period of four years from Jan. 1, 1891, at $18,000 per annum, which is equivalent to $90 per lamp per annum. The tower lights are to be abandoned, it is said, for a better system, as they have not proved satisfactory. Suspended lights at the intersection of streets will take the place of the towers.

Mansfield, O.—The city will ask the Legislature for authority to issue bonds in the sum of $15,000 to build an electric light plant to furnish light for the streets and public buildings.

Rockport, Ind.—The Rockport Water Co. has been granted a franchise for an electric light plant. A plant of 500 lights capacity. No particular system has been decided upon as yet, but such a system will be chosen as is adapted to both commercial and municipal lighting.

Chicago, Ill.—The Metropolitan Electric Light Co. has been incorporated by G. L. MCKEON, J. A. MEDICO, and A. H. KINGMAN. Capital stock, $300,000.

Petersburg, Ill.—The Electric Light & Power Co. has been incorporated by C. D. WRIGHT, J. G. STRODTMANN, and T. W. MCNEELY. Capital stock, $25,000.

Olathe, Kan.—The Olathe Electric Light & Power Co. has been incorporated by B. T. WHITMORE, WELLINGTON ADAMS, and CHARLES SMITH. Capital stock, $25,000.

Eagle Pass, Tex.—The Texas & Mexican Electric Light & Power Co. has been organized. Capital stock $10,000.

San Francisco, Cal.—The San Francisco Electric Light & Power Co. has been incorporated: MARTIN BULGER, ROBERT P. HASTINGS, WILLIAM MCMANN, J. M. CHENOWITH, W. C. CLARK, H. G. PLATT and J. S. HUMBIRD. Capital stock, $1,000,000.

Ingersoll, Ont.—At the last meeting of the Town Council, Col. R. B. HAMILTON notified the corporation that the Heisler Electric Light Co. would not accede to the agreement made by him for lighting the town with their system. The Electric Light Committee will go to St. Mary's and inspect the system in use there in a few days, and try to form a contract with another company.

SEWERAGE AND MUNICIPAL.

Water Power.—At Winnipeg, Man., the aldermen have invited proposals for the construction of the Assiniboine water-power works. The works are to be constructed in accordance with the plans approved by the Governor-General in Council, the specifications and details to be prepared by the City Engineer. The city will require a reserve of power up to 1,000 H. P., in return for which the right to construct the works and the remainder of the power will be handed over to the contractor.

Sewerage.—*Framingham, Mass.*—The Sewerage Committee has reported that the system of sewage disposal devised by S. C. HEALD, C. E., a copy of which is on file at the office of the Boston Water Board, has been completed, so far as is referred to in a letter from the Boston Water Board, signed by H. T. ROCKWELL, then chairman of said board, dated February 1888, all of which relates to the completion of so much of the system as provides for the irrigation fields, force main, pumping plant, and trunk sewer from Bridge St. to the pump, and the sewerage committee gives notice that the same is in use and operation. Already several of the business blocks have been connected with the town sewer, and numerous private applications have been made for the same privilege.

Troy, N. Y.—City Engineer BAERMANN states that about one-third of the city has been surveyed for the new sewer-sy-tem, and transit lines have been run over the greater part of the city. The sewers running north and south are generally in bad shape and the sewers running east and west are in pretty fair condition.

Alexandria, Va.—The Council will appoint a committee to investigate the question of establishing a sewerage system.

Fort Payne, Ala.—An ordinance has been passed authorizing the issue of $50,000 of city bonds for sewerage, etc.

Passaic, N. J.—The contract for a sewer discharging into the Passaic River has been awarded to Patrick Plunkett, of Hoboken, N. J.

Oakland, Cal.—The trustees have been in correspondence with Mr. RUDOLPH HERING, C. E., of New York, in regard to preparing plans for a sewerage system.

Houston, Tex.—A main drain or drainage conduit is to be built in the Chartres St. drainage district.

Street Work.—*Mobile, Ala.*—A considerable amount of street paving is being undertaken. Brick is being generally used.

Seattle, Wash.—The Front St. Cable Rv. Co. has decided to pave its line with basalt blocks. The bituminous rock pavement is said not to have stood well under heavy traffic.

Milwaukee, Wis.—The pumps at the flushing tunnel station have been idle during the last two weeks. The lake water was too muddy, and if pumped into the river it would not have been much of an improvement on the river water. As soon as the lake water gets clearer, it is Engineer BENZENBERG'S intention to start the engines again and to keep them running for a week or so until the cold becomes stationary. By Dec. 20, it is thought, the flushing tunnel works will be stopped for the entire winter.

Gas Lighting.—The Elizabethtown (N. Y.) Gas Light Co. has been awarded by the City Council the contract of lighting the city for three years at $13.50 per lamp. The contract also gives the city the privilege of erecting over 200 additional lamps.

WATER-WORKS.

NEW ENGLAND.

Portland, Me.—The company has completed the repairs to the Cobbosseecontee dam.

Andover, Mass.—We have received a report stating that the new works will be completed in June, 1890. Work was begun in October. The supply is pumped from Haggetts Pond to a reservoir of 1,250,000 galls. capacity. The duplex direct acting 1,728,000-gall. pump was furnished by the Geo. F. Blake Mfg. Co., of Boston; pipe and specials, R. D. Wood & Co., of Philadelphia, Pa.; trenching and pipe laying, Chas. H. Erlee, of Flushing, N. Y.; valves and hydrants, Ludlow Valve Mfg. Co., of Troy, N. Y. There are 20 miles of mains, and 160 hydrants. Estimated cost, $150,000; procured by 4 per cent. bonds. Engineer, PERCY M. BLAKE, of Hyde Park' Superintendent, JOHN E. SMITH; Secretary Water Board, FELIX G. HAYNES. Population 6,500.

Boston, Mass.—The following order has been introduced in the City Council by Councilman ROSONSKY for future consideration:

That the Board of Fire Commissioners be directed to examine and report on the cost and expediency of establishing a system of pipes through the business district to be used in case of fire, the water to be taken from the harbor and delivered at hydrants under pressure from a pumping station on the water front.

North Adams, Mass.—The new works will soon be connected with the old system, after which about half of the town's supply will be taken from Broad Brook, in Williamstown. The main pipe is about 7 miles long. Work was begun on June 23.

Springfield, Mass.—The report of the Water Commissioners on improvements to the water supply has been accepted by the Finance Committee and the City Council. Orders have also been passed appropriating $10,000 for making such improvements as can be carried on this winter, and authorizing the mayor to apply to the next Legislature for authority to execute the work as outlined in the adopted plans.

Holliston, Mass.—Work will not be commenced until spring.

South Norwalk, Conn.—We have received the following information from W. B. RIDER, Engineer of the new works:

The city has voted unanimously to extend the system to East Norwalk. Estimated cost of the additional work, $12,500. Work on the reservoir for the South Norwalk works is progressing favorably.

MIDDLE.

Sidney, N. Y.—The new works have been completed, and satisfactorily tested. Engineer, W. B. RIDER, of South Norwalk, Conn. There are 5 miles of mains, and 26 hydrants.

Green Island, N. Y.—The company has completed the laying of the pipe across the basin to carry water from the pumping station to the reservoir in West Troy.

Rochester, N. Y.—A supplemental report has been sent to the Chamber of Commerce by Consulting Engineers J. T. FANNING and A. FTELEY, replying to the review made of the original report by Chief Engineer J. NELSON TUBBS.

Canajoharie, N. Y.—WM. J. ARKELL, WM. HATTER, and RUDOLPH SPRAKER have purchased the plant of the Cold Spring Water Co., and a large interest in the old company, and consolidated them under the name of the Consolidated Canajoharie Water Co. Capital stock, $25,000.

Albany, N. Y.—A satisfactory test of the pipe line system connecting the new reservoirs has been made. The estimated cost is $20,000.

Bordentown, N. J.—It is reported that the expert employed by the Board of Health to report upon means of obtaining a pure water supply will also recommend filtering the Delaware River water.

Jersey City, N. J.—The Lehigh Valley Railroad Co. has renewed its proposition to supply the city with water. By the original proposition they offered to furnish water at $42 per 1,000,000 galls. The company now state that in view of its Newark contract it can afford to reduce its bid to $39.

Philadelphia, Pa.—Members of the City Council, officers, and others interested in a water supply company, have recently made an investigating visit to Reading to inspect and negotiate for the purchase of, the property and franchise of the Schuylkill Navigation Co. The plan is to purchase the canal for $7,000,000, or to lease it at $325,000 per annum, and to use the canal as an open aqueduct to convey the water of the river to Philadelphia. As the demand increased the company would divert into the aqueduct all the tributaries of the river along its course. The party was in charge of General Superintendent I. A. SWEIGARD and E. F. SMITH, Chief Engineer of canals.

Scranton, Pa.—The 1,200,000,000 gall. reservoir on Roaring Brook, at Dunnings, forming part of the storage system of the Scranton Gas & Water Co., was completed in November, and is now in use. Work was begun in 1887. It is a combined structure of masonry and earthen embankment, and consists of a main dam and two wings, the total length being about 2,200 ft. The total estimated cost is $300,000. Engineer, E. SHERMAN GOULD. Contractors, Burke Bros.

Washington, D. C.—The work of laying the 48-in. mains over Rock Creek has been completed as far as it can be done by the Phœnix Bridge Co., and excavation will soon be commenced on M St. for the pipes toward the M St. bridge.— Permission has been granted to Major ERNST to lay new pipe for the spring in Franklin Square to supply the executive mansion with water.

Jamaica, N. Y.—A compromise has been effected between the two companies, settling the dispute of right to certain territory, on which both claimed the right to lay mains and furnish water.

Brooklyn, N. Y.—Commissioner of Public Works ADAMS has awarded contracts for the new work, divided into eight sections, as follows:

Section 1.—Cranford & Valentine....	$1,013,772
Section 2.—Edward Feel	702,578
Section 3.—John McNamee.....	75,659
Section 4.—John H. O'Rourke.	154 8 5
Section 6.—John McNamee	405 986
Section 7.—Charles Hart	392,7-4.20
Section 8.—Cranford & Valentine ...	432,183
Total	$3 295,509.20

[The address of all the successful bidders is Brooklyn, N. Y. An outline of the work included under each section was given in our issue of Nov. 23, p. 504. The contract for Section 5 has not yet been awarded.—ED.]

SOUTHERN.

Portsmouth, Va.—It is reported that the company is to make arrangements to operate the engines by water power.

Gordonsville, Va.—The new works are nearly completed. Water is conveyed by gravity from springs to two reservoirs.

Reidsville, N. C.—It is reported that $10,000 of bonds will be issued for constructing works. Also that Mr. BURLINGAME, of Providence, R. I., is preparing estimates.

Henderson, N. C.—J. H. BRIDGERS Clerk, informs us that surveys are being made for locating a system of works.

Cordele, Ga.—A majority vote of 97 has been cast in favor of establishing works. Estimated cost, $70,000. Steps toward construction will be taken at once.

West Knoxville, Tenn.—It is reported that the company is going ahead with its project, and is soon to start an engineer on preliminary surveys. Also that West

Knoxville will make a contract with the new company.

Fayetteville, Tenn.—The Fayetteville Water-Works Co. is reported to have been incorporated by W. C. MORGAN, W. K. BRYSON, J. F. HEALY, and others.

Richmond & West Point Terminal.—The annual report of this company, operating 7,020 miles of railway and 500 miles of water lines comprising the Richmond & Danville System, the East Tennessee, Virginia & Georgia System, and the Central R. R. of Georgia System shows the following results from operations during the last fiscal year:

Gross earnings	$28,294,461
Operating expenses	18,457,654
Net earnings	$9,836,807
Fixed charges	7,877,025
Surplus over fixed charges	$1,959,782

All of the auxiliary roads showed a surplus except the Central Railroad of Georgia, which had a deficit of $144,375 to meet fixed charges.

Thomasville, Ga.—Additional mains are being laid.

NORTH CENTRAL.

Marion, O.—All attachments against the Scioto Water Co. have been released, and the prospects of the town having a system of works are more encouraging.

Jackson, Mich.—The water Commissioners have passed resolutions in favor of adopting meters and self-closing faucets, to stop the waste of water. Also to construct a new reservoir, and purchase a steam fire engine.

Adrian, Mich.—The works have been accepted by the city. An annual rental of $10,000 is paid for fire protection.

Romeo, Mich.—The town wants a system of works established. A citizens meeting was held on Dec. 12, to consider the matter

Grand Rapids, Mich.—The Committee appointed to consider the proposition of the New York Contract Co., to purchase the works, and furnish the supply from Lake Michigan, as well as that of M. R. Crow, offering to buy the city's plant, or to sell the Hydraulic Co's. plant to the city, has reported in favor of retaining the present plant, and stated that it would probably be good policy to buy the Hydraulic Co's. plant if it could be obtained at its true value. A complete history of the works is given in this report. It was unanimously adopted.

Jacksonville, Ill.—The artesian well being sunk to increase the city's supply has reached a depth of 2,007 ft. The contract calls for a well 2,500 ft. deep if necessary to obtain water.

Belleville, Ill.—A suit has been commenced by the American Loan and Trust Co., of New York, against the City Water Co., and the unknown owners and holders of the second mortgage bonds of the company, to foreclose a mortgage on all the property of the company, to secure the payment of $175,000 worth of bonds. Receiver, MADISON T. STOOKEY.

Joliet, Ill.—It is reported that bids will soon be wanted for cast iron pipe and specials.

NORTHWESTERN.

Boone, Ia.—The city has closed a contract with J. P. Miller & Co., of Chicago, to continue work on the artesian well. It is now down 1,882 ft. The contract price is $4 per ft., to a depth of 2,000 ft., and $4.50 for each additional foot for 100 ft.

Alexandria, Minn.—F. P. CLOUGH informs us that the new works will be completed on Dec. 15. Water is furnished from 30 2½-in. driven wells by direct pressure. There are 2 miles of mains and 20 hydrants. Contractors, E. T. Sykes & Co., of Minneapolis. Engineer, F. H. TODD, of St. Cloud. Pipe and specials were furnished by the Shickle, Harrison & Howard Iron Co., of St. Louis. Cost $15,000, procured by 7 per cent. bonds.

New Ulm, Minn.—LOUIS SCHILLING informs us that the new works will be completed about Jan. 1, 1890. The contractors are Fairbanks, Morse & Co., of St. Paul. The supply is conveyed from a deep well to a reservoir, thence to a tower. Cost, $15,000, procured by bonds.

Winona, Minn.—The following recommendation has been made by the Water Commissioners, and is now under consideration:

That on all water connections, when the pipe leading from the city mains is 2 ins. or more in diameter, water meters be put in and the water paid for at meter rates.

Duluth, Minn.—The company has expended the following sums in improvements during the past year:

Constructing new reservoir	$34,000
Purchasing 12⅛ miles cast-iron pipe	90,000
Laying " " " "	105,000
Total	$229,000

It is reported that the contemplated improvements for 1890 will exceed those made during the past season, and will include the addition of a 5,000,000-gall. duplex pumping engine. WILLIAM CRAIG is the Superintendent.

Leavenworth, Kan.—President L. T. SMITH has awarded the contract for paving the interior of the large settling reservoir, now under construction, to W. J. Gilfellow. Flagstone from the Fort Scott quarry will be used for that purpose. The estimated cost is $15,000.

Fort Wingate, N. M.—It is reported that a system of works is being constructed.

Iroquois, So. Dak.—Bids will be received until Jan. 1, 1890, for sinking a 6-in. artesian well, by W. H. LEVY, Clerk. No bids will be accepted unless approved bonds are furnished. J. J. SWEET is Chairman Board of Trustees.

St. Paul, Minn.—Reports have been submitted to the City Council by Superintendent OVERTON, Secretary CAULFIELD, and Attorney FOLSOM. As interesting in these columns we extract from reports as published in the *Pioneer Press* as follows:

Supt. OVERTON has prepared plans for laying 19 miles of new mains in the high service, and about 3 miles in the low service, next year, at a total estimated cost of $144,419.50.

The question of adding to the water supply by artesian wells has been considered by the board, and it has been decided to sink a well at the Vadnais station and another at the new Baldwin lake station and turn their flow into the conduits. If these experiments result in what is expected, a system of artesian wells, connecting with the works at different points in the area traversed, may be a thing of the immediate future.

In Attorney FOLSOM's report on the future works, the past discussion on a new source of supply, etc., he states that if all available water is wisely stored from the present drainage area of 224 miles, that no new source of supply will be necessary; also that he has been unable to find a source that will supply the city with more water than the present system. He does not consider the amount of water that could be obtained from Mille Lacs sufficient to warrant the expenditure of $8,553,600 for constructing an 8½ mile aqueduct, and developing this plan and also dismisses the St. Croix River plan as impracticable for a gravity system of works. In conclusion he makes the following statement:

Another source of supply, if pumps are to be used, is the Mississippi River. Pumps can be placed 25 miles above St. Paul, and the water forced into our present system of lake storage, through pipes, a distance of about 7 miles.

Argentine, Kan.—A satisfactory test of the supply wells has been made. The new works will soon be put in operation.

Omaha, Neb.—Twenty-five acres of land, on which to construct a 100,000,000-gall. storage reservoir, has been purchased by the American Water-Works Co. for $40,000. The estimated cost of the work when completed is $1,000,000. The land is 340 ft. above the level of the river, and will afford a hydrant pressure in the city of 120 lbs. per square inch. Water will be supplied through a 48-in. pipe laid through Boulevard St. from Thirtieth St. Work will probably be commenced in the spring.

Randolph, Neb.—The works have been completed. Water is conveyed from tubular wells to a tank. Estimated cost, $5,000. Contractor, S. W. Mosher. Clerk, E. F. BENNETT.

Pawnee City, Neb.—The new works have been completed, and put in operation. Water is pumped to a stand-pipe.

Watertown, So. Dak.—S. A. Kean & Co., of 115 Broadway, New York, are now offering $80,000 of 20-year 6 per cent. bonds for sale.

Mandan, Dak.—Bonds for $10,000 will be issued for sinking an artesian well.

Bozeman, Mont.—The new works were put in operation Nov. 23. The contractors were R. B. C. Bement & Co., of St. Paul, Minn.

SOUTHWESTERN.

Ballinger, Tex.—Works are projected. Address the City Clerk.

Austin, Tex.—A plan has been projected to obtain a new water supply for the city by building a dam across the Colorado River.

Bonham, Tex.—It is reported that a contract has been closed for works to cost about $20,000.

Austin, Tex.—The city has been discussing the advisability of constructing and owning its own works, instead of entering into a contract with the water company at the expiration of the present contract in 1892. One plan is to form an impounding reservoir by building a dam across the Colorado River. JOHN MCDONALD, Mayor, is interested in the matter.

Petersburg, Col.—The town is to be supplied from South Denver.

Denver, Col.—Articles of incorporation have been filed by the Lookout Water Supply Co. The company's plan is to take water from Chicago and Beaver lakes, and Beaver and Soda creeks. Water is to be supplied to Golden and Lookout Mountain Resort. Capital stock $10,000. The directors are: A. C. FISK, BIDDLE REEVES, C. C. WELSH, ISHAM B. PORTER, R. W. WOODBURY, H. C. STUART and E. F. HALLECK.——Bids were received on Dec. 9 by the Citizens Water Co., for laying 14 miles of 30 in. pipe.——The Beaver Brook Water Co. have nearly completed their pipe laying to supply citizens on the Boulevard, and Villa Park, with water.

PACIFIC.

Seattle, Wash.—The two surveying parties now laying out the route for taking the city's supply from Rock Creek will complete their work about Dec. 20. Plans and specifications will then be prepared by BENEZETTE WILLIAMS, Consulting Engineer, of Chicago, Ill.

Seattle, Wash.—(Queen Anne, a suburb.)—We have received the following information from E. BRYAN:

The Union Water Co. has contracts under way for a system of works to cost $140,000. They are to be completed by March 1, 1890. Water will be pumped from Lake Union. President, D. T. DEMY; Secretary and Treasurer, E. BRYAN. Engineer, THOMAS GOWAN.

Corvallis, Ore.—Dr. G. R. FARRA has purchased sufficient stock to give him a seven-eighths interest in the company.

Portland, Ore.—Bids will be received until Dec. 31, for $50,000 of 30 year 5 per cent. bonds, by FRANK T. DODGE, Clerk of the Water Committee.

Oakland, Cal.—It is reported that the Contra Costa Water Co. will increase its capital stock from $3,000,000 to $6,000,000, for the purpose of extending and improving its plant.

San Bernardino, Cal.—Bids are wanted for constructing a system of works by the Water-Works Trustees. The specifications call for a continuous flow of 60 ins. of water, to be conveyed through iron or steel pipes to a 4,000,000-gall. reservoir, to be constructed at an elevation of not less than 200 ft. above the intersection of Third and E. Sts

Salt Lake City, Utah.—At the annual meeting of the stockholders of the El Dorado Land & Water Co., the following officers were elected; CHARLES S. WILKES, President; E. D. R. THOMPSON, Vice-President; W. A. PARKHURST, Secretary and Treasurer.

CANADA.

Ste. Cuneyonde, P. Q.—The City Council has purchased the water-works complete from Mr. BERGER for $400,000.

ARTESIAN WELLS.

Austin, Tex.—The well being sunk in the capitol grounds has reached a depth of 500 ft.

Mandan, Dak.—The town has voted to issue $10,000 of bonds for sinking a well.

Vilas, Dak.—A well is to be sunk.

Brunswick, Ga.—A well is being sunk.

IRRIGATION.

Grand Junction, Col.—A plan for constructing the Highline Canal is being formulated in Denver from statistics gathered in the recent survey made by Engineer KENDRICK. It is estimated that 90,000 acres of land will be reclaimed in Mesa County by this canal.

Santa Fé, N. M.—Work has been begun on the canal to be constructed through the Messilla Valley, at the Rio Grande River, above Fort Selden. It is to be 35 miles long, and extend to the Texas line, near El Paso. Right of way, with privilege of extending the canal through the Military Reservation, has been secured from the Government. The promotors of the project are: W. H. H. LLEWELLYN, F. W. SMITH, H. F. GRIERSON and others, of Las Cruces.——Advices from San Juan County, New Mexico, state that the irrigating canal of The San Juan South Side Co.'s canal is nearly completed. It is 20 miles long, and was built with private capital furnished by residents of Southern Colorado and Northwestern New Mexico.

San Diego, Cal.— The Spring Valley Irrigation District has been organized. The district embraces 22,000 acres.

Helena, Mont.—The Yakima Canal & Land Co. has been incorporated by WALTER N. GRANGER, ALBERT KLEINSCHMIDT, and JOHN D. MCENTYRE. The capital is $1,000,000.

Washington, D. C.—A bill has been introduced by Senator MOODY directing the Secretary of the Interior to cause the necessary surveys to be made and artesian wells sunk to develop the artesian basin underlying the State of South Dakota, with a view to using of the water for irrigation. An appropriation of $150,000 is asked for.

San Diego, Cal.—The People's Sweetwater Irrigation Co. has been incorporated. The directors are: F. A. KNOX, F. E. BELDEN, EDWIN A. WELLS, NAT KENNEDY and M. S. BABCOCK. The capital stock is placed at $5,000,000.

East St. Louis, Mo.—At the annual meeting of the shareholders of the Taos Valley Irrigating Co., operating in New Mexico the following officers were elected GEO. MINCH, President; C. S. ITTNER, Vice-President; J. M. PIPER, Secretary; F. S. VAN ARNAM, Treasurer; G. ELLIOTT, Attorney.

Gothenburg, Neb.—The dams for the canal reservoir are nearly completed. Work on the canal is progressing rapidly.

St. Paul, Minn.—Bids were received by the Lincoln County Ditch Reservoir & Land Co., on Dec. 5, for the construction of a ditch and dam to be completed by April 1, 1890. C. J. BERGUNTHAL, Secretary.

Fort Collins, Col.—The Larimer & Weld Canal Co. have had a corps of engineers looking for a feasible line for a ditch to be taken out for the purpose of filling their reservoirs, which are to be established in this vicinity. Negotiations are still pending for the purchase of the Jackson ditch, which will be used for a like purpose.

New York, N. Y.—An exhaustive paper was read before the members of the Chamber of Commerce on Dec. 5, by Major J. W. POWELL, outlining plans, and offering suggestions for irrigating arid lands.